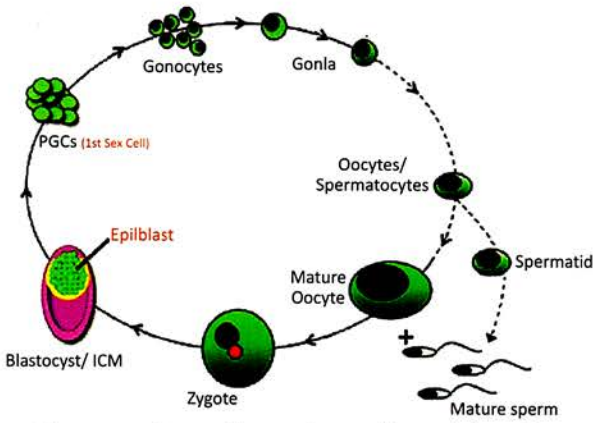
Anatomy

General Embryology

Gametogenesis



Zygote is having maternal and paternal nuclei and it is going to divide multiple times. Finally a structure is formed called as the **blastocyst**. In the blastocyst there is inner cell mass and in the **inner cell mass** there will be some of the **epiblast cell.** These epiblast cell are the one which form the **primordial germ cells**. Primordial germ cells are the **first sex cells of our body**. These Primordial germ cells give us the **gonocytes** and the **Gonia** and then the **Primary and secondary gametocytes**. Primordial germ cell has the capacity to form the **male and female gametes** depending upon the presence of **y chromosome** (form sperm), **if we do not** have the y chromosome then it is going to form the **oocytes**

Comparison of Mitosis with Meiosis

Mitosis is an equational division; it is not going to change the chromosome number. **Meiosis 1 is reduction division** because it is going to reduce the chromosome number to half.
In Mitosis, we can see diploid cell with two units of DNA (**[2n, 2N]** – small n is number of chromosomes and capital N is amount of DNA.)
It is understood that we will be having one unit of DNA from Mother, and one unit of DNA from father .Similarly ,there is a pair of chromosomes always, 23 pairs of chromosomes (one from mother and one from father)
Before any cell division ,there should be DNA duplication and that happens in the **interphase.**
The cell remains diploid but there are four units of DNA. There is a duplicated chromosomes appearance and there are sister chromatids available. As they proceed further through Prophase, Metaphase , Anaphase and Telophase. During Anaphase they are going to pull apart means the maternal and paternal chromosomes have already duplicated – there chromatids and from each parent one of sister chromatid is being pulled towards the opposite pole ,so finally chromosome status remain the same and it is a diploid cell with two units of DNA **(2n,2N)–There is no change of chromosome number if we are talking about mitosis .But in Meiosis we can see that ,there will be definitely haploid structure that is (n,N).**
In Meiosis – Starting with Diploid cell **(2n,2N)** there is DNA duplication (before cell division) resulting in diploid cell with four units of DNA.**(2n,4N)** → a prophase stage of Meiosis 1.
In Prophase stage of Meiosis 1, there will be certain sub divisions like

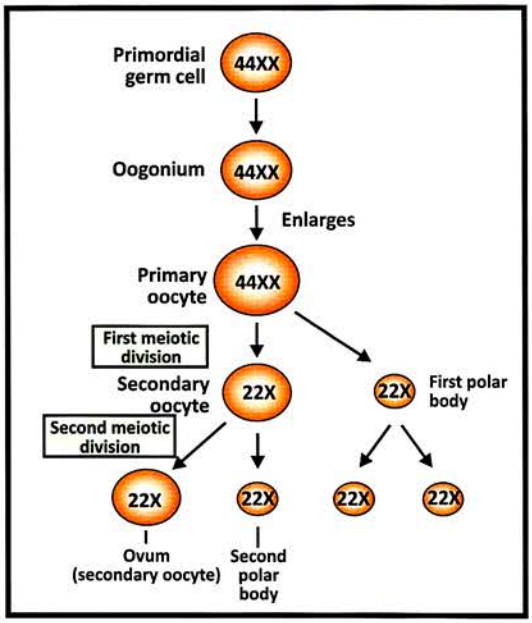
1. Leptotene
2. Zygotene

3. **Pachytene (Chiasma formation, genetic exchange between paternal and maternal chromosomes .)**
4. Diplotene

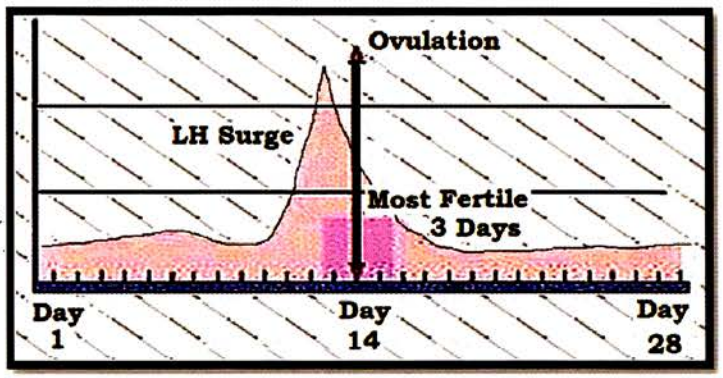
Blue and Red chromosomes as shown (that is maternal and paternal) they have **interchanged** some of the genetic material , followed by **secondary gametocytes** (sec oocyte or sec spermatocytes) they are **haploid** with two units of DNA **(n,2N)**.followed by **Meiosis 2** that is separation of sister chromatids (just like Mitosis).

So in MEIOSIS 1, Maternal and paternal chromosomes are going to separate leading to haploid cells where as in Meiosis 2 chromatids are going to separate. As sister chromatids are separated we finally get the gametes (haploid cell with one unit of DNA).

Primordial germ cell : Primordial germ cell (First sex cell) is going to give rise to **oogonium** and then **Primary oocyte**. This step involves Mitosis. After that Primary cell enters Meiosis 1. **Primary oocyte or Spermatocytes is the largest of all the cells**. Primary oocyte or Primary Spermatocyte is undergoing **MEIOSIS 1 (2n,4N)** (We started with 2n,2N but due to DNA duplication we see 2n,4N) After that maternal and paternal chromosomes are separating during Meiosis 1. Secondary oocyte or gametocyte will be haploid (with two units of DNA). Then comes Meiosis 2 ,where **sister chromatid separate** followed by formation of cell (haploid with one unit of DNA).

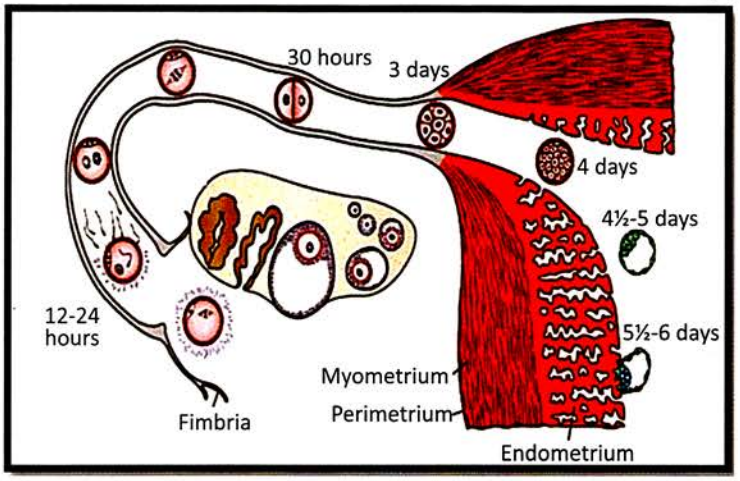


Menstrual Cycle



It is a **28 days** cycle.
Day 1 beginning
Day 28 ending.
The diagram shows the **LH hormone concentration** showing elevation before ovulation
Day 14 is the Mid cycle –day of ovulation
before that we have LH surge .
LH surge → 36 hrs before ovulation
LH peak → 12 hrs before ovulation
that is the time when **first polar body is released. First polar body is released at LH peak**
2nd polar body released after fertilization
(Fertilization takes place 24 hrs after ovulation) For a female ,**the fertile period is 24 hrs after ovulation** otherwise the **secondary oocyte is degenerated and menstruated at the end of cycle.** If the sperm ejaculated in female within **2 days /48hrs then** only **it will fertilize** the ovum. **Survival time** after ejaculation in female can be as much as **5-10 days**. Some female can be fertilized as long as 7th day of ejaculation (Rare). Once sperm Is ejaculated may be **day 12,13 or 14** ,then there is chance that baby will be formed. But if the sperm are ejaculated **before day 12 or after day 14** then there is **no chance** that baby will be formed. Fertile period is only 3 days (Day 12 to Day 14 most Fertile period)

Ovulation, Fertilization and implantation



Ovary undergoes ovulation and secondary oocyte is ovulated covered by **zona pellucida,** Glycoprotein membrane to attract sperm (attracting it in the **ampulla of fallopian tube fertilization will occur** .Fertilization should occur **within 24hr** of ovulation. Zona Pellucida will now deflect the sperm to **prevent Polyspermy.**

Day 1 Single cell structure

Day 2 Two cell structure

Day 3 Morula (can be 12 cells, 16 cells, 32 cells, 54 cells)

(**Advanced Morula** 16-64cell stage which enter uterine cavity at Day 4)

By **end of Day 4 it becomes blastocyst.** Blastocyst is still covered by zona pellucida.

At Day 5 zona pellucid is lost and **Day 5 is the beginning of implantation** and **completed on Day 12.**

Day 5-6 is the time when **blastocyst was attaching to endometrium.**

When does **implantation happens 7-9day** (Post ovulation/Post fertilization)

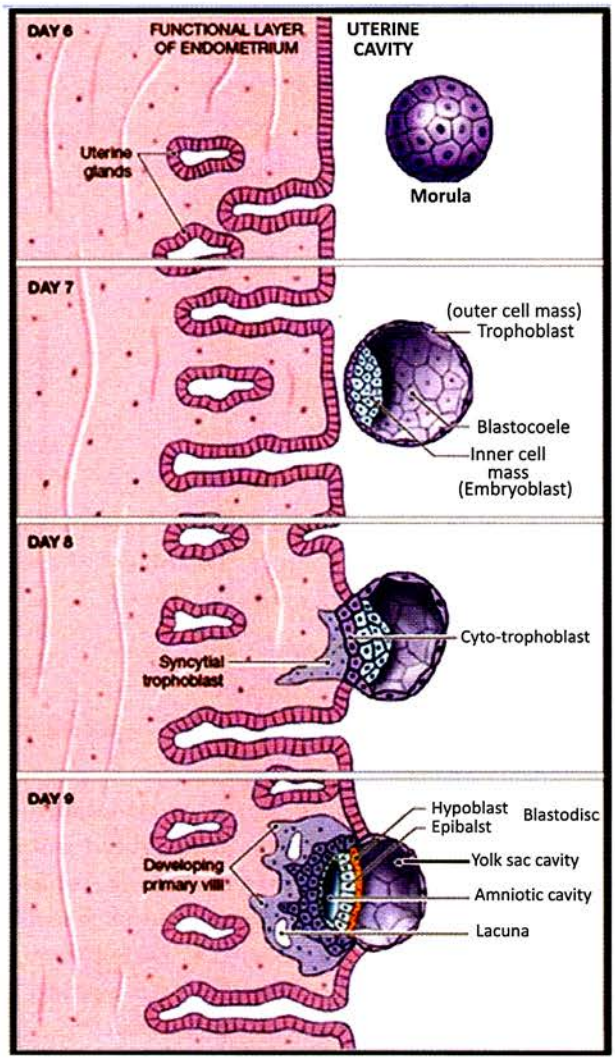
Process of implantation

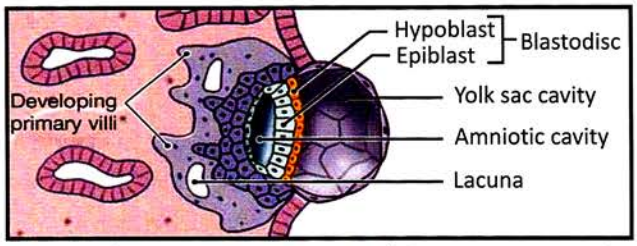
Advanced Morula enters the uterine cavity (16-64 cell stage) This Morula changes to blastocyst (Day 4 end) and is still covered by zona pellucida. It is having inner cell mass called **embroyblast** which forms the **embryo** .

Trophoblast is the outer cell mass which is going to form the placenta. Embryoblast and trophoblast are going to divide into two each ,Trophoblast will divide into **cytotrophoblast and syncytiotrophoblast** . **Embryoblast will divide into Epiblast and Hypoblast** and it happens on **Day no 6-8.** Day 6-8, we can see different types of cells are formed.

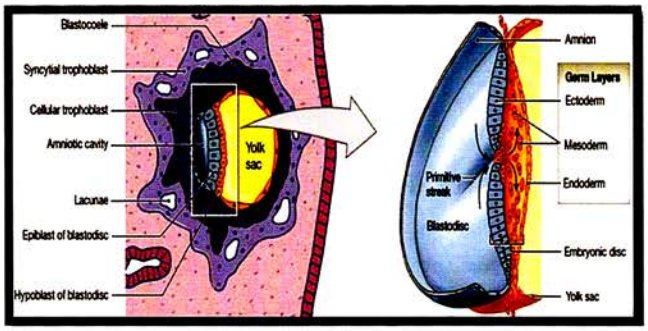
In 3rd Stage **Syncytiotrophoblast which helps in attachment with endometrium on day 6** and cytotrophoblast which also contribute towards placenta.

Whereas towards inner cell mass **Epiblast** and **Hypoblast** will be formed ,along with that, **2 cavities** are also formed (**Dorsal cavity Amniotic cavity, Ventral cavity is Yolk sac cavity**)

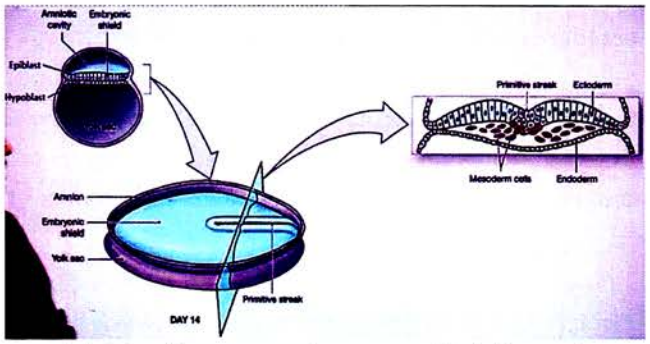




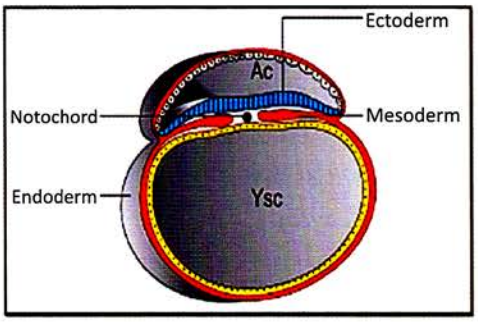
In the magnified image ,we can see **Hypoblast is ventral and epiblast is dorsal** and towards **dorsal side is amniotic cavity** and towards **ventral side is yolk sac cavity**. The **floor** of amniotic cavity has **epiblast and roof** of amniotic sac has **hypoblast cells. Cytotrophoblast cells are towards the embryo** and **synctiotrophoblast** which have lost their cell membrane are helping to **attach to endometrium** is going to help to form the villi also. The **Primary villi has cyto-syncytiotrophoblast** then later it will form secondary and tertiary villi.



In next stage **Epiblast cell undergo proliferation to form primitive streak** and then they start **migrating Ventral** .As they migrate ventrally they are going to form **first the Endoderm** ,then mesoderm and at last ectoderm . It means **all the germ layers come from epiblast** which are migrating ventral and in this process ,they **replace the hypoblast cells** (which move out of embryo because embryo is basically epiblast cells).



In the given image ,we can see there is a dorsal amniotic cavity and ventral is yolk sac cavity. Roof of yolk sac cavity is hypoblast which will be **removed by epiblast migrating ventrally** and epiblast cells are undergoing proliferation to form primitive streak .**Primitive streak appears at the caudal end** of the baby and **migrate towards the cephalic end** of the baby. **But gastrulation is reversed ,it is Cephalo- caudal.** The three germ layers are first formed near the head then towards the tail. **Epiblast cells are seen towards the dorsum** and **they are going to migrate towards ventral**. As the epiblast cells are going towards ventral side they are going to replace the hypoblast and **becomes endoderm which is the first germ layer to be formed.** In the middle, **mesoderm is formed** and more **dorsal ectoderm** is formed. **All the germ layers coming from epiblast cells and this process is called gastrulation** and this will happen **in the 3rd week** of the **post ovulation/post fertilization.**

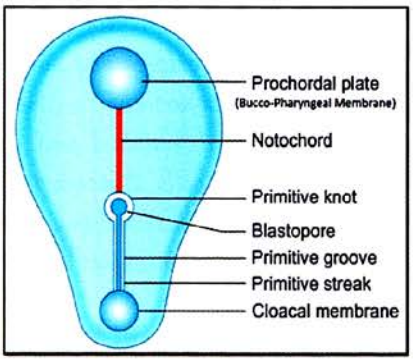


The given image is transverse section of embryo **post gastrulation** . Dorsal is amniotic cavity, floor is ectoderm, middle is mesoderm and more ventral , lining the yolk sac cavity Is the endoderm. There is a notochord/axial mesoderm, **they Stimulate the overlying ectoderm to form the nervous system.** There are two types of ectoderm 1.**Central: forms the Nervous system** 2.**Peripheral: Skin epithelium**

Notochord will later become Nucleus Pulposus of inter vertebral disc.

Formation of primitive streak and its various Components

It will be **appearing at the caudal end of the baby** and **grows towards the cephalic end** of the baby. Towards the cephalic end develop the membrane called **bucco-pharyngeal membrane** and towards the caudal end develops the membrane called **cloacal membrane.**



Epiblast cells lying at the floor of the cavity are undergoing proliferation to form the primitive streak .

The primitive streak has three parts:

1.Primitive Groove

2.Primitive knot

3.Primitive Pit

As epiblast cells are proliferating and forming the primitive streak, some of the epiblast cells jump to pit and go ventrally and replace the hypoblast cells (which are deeper) **and change the hypoblast cells into endoderm.**

Endoderm will be more ventral, if we go dorsal there is layer which is formed in the middle known as the mesoderm. Even this mesoderm is formed by the Epiblast cells.

So in short these **epiblast cells as they go ventral they form endoderm**, form the mesoderm and the epiblast cells which remain dorsal they will be forming the ectoderm. The floor of amniotic cavity will now have all layers.

Ectoderm and the endoderm they fuse at some level towards the cephalic – buccopharyngeal membrane and clocal membrane , which is towards the caudal end .

Both Clocal membrane and bucopharyngeal membrane doesn't have mesoderm because of fusion dorsal ectoderm with ventral endoderm.

Some of epiblast cells migrate towards the pit and go towards the buccopharyngeal membrane and they are going to form the Notochord. **So ,notochord is formed by the epiblast which are lying between the primitive pit and the bucopharyngeal membrane. The Notochord is also called as Axial Mesoderm.** The Axial mesoderm stimulates the dorsal epiblast or the dorsal ectoderm to form the nervous system.

Tubes formation by the Germ Layers

Floor of amniotic cavity has ectoderm which forms **neural plate ectoderm, neural groove and then neural tube.**

1. **Neural tube forms** central nervous system- (the brain and the spinal cord.)
2. **Endoderm lining the yolk sac cavity** The gut tube
3. **Cardiovascular tube** – it has cardiac muscles and the smooth muscles which comes from mesoderm.

The three germ layers are:

Dorsal - Ectoderm,

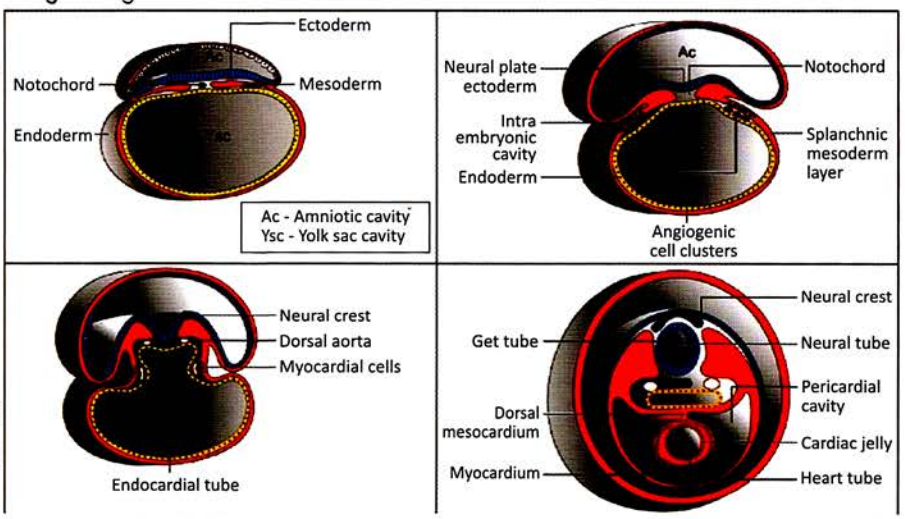
Middle - Mesoderm,

Ventral - Endoderm

The cavities are:

Dorsal cavity - Amniotic cavity

Ventral cavity - Yolk sac cavity



Mesoderm will form the Notochord or axial mesoderm. Notochord is important because it will stimulate the overlying Ectoderm which will form **the neural plate ectoderm.** And at the **periphery** (Right and left side) that is **surface ectoderm.** Surface ectoderm on right and left side follows a **rule "that an external opening should be lined by surface ectoderm".**

External opening can be oral cavity-i.e. Glands are formed called **pituitary gland (at the roof that is Rathkes pouch)** also the **salivary gland, sub-mandibular gland, sublingual salivary glands.** Surface ectoderm also forms the **skin** and the **skin glands like sweat glands or sebaceous glands. Neural plate ectoderm forms the central nervous system-Brain and spinal cord. Ganglia comes from the peripheral nervous system** (formed by **neural crest cells,** Neural crest cells are the **fourth germ layer** derived from **epiblast cells** [earlier we believed that neural crest cells were derived from neuroectoderm])

Neural crest cells also form secondary mesenchyme (secondary mesoderm) in the **anterolateral area of head and neck region.** In the head and neck region it forms the **skull bones, eye ball, pharyngeal arch** components like **mandibular bone, hyoid bone, Aortopulmonary septum** of developing heart.

Applied- In **DiGeorge syndrome** there is a problem of the neural crest cells in the head and neck region leading to **skull defect, Eyeball defect, Pharyngeal arch defect like small mandible, aorto-pulmonary septum anomalies like TOF, Transposition of great vessels.** And the **most common cause of death in DiGeorge syndrome is the AP septum anomalies.**

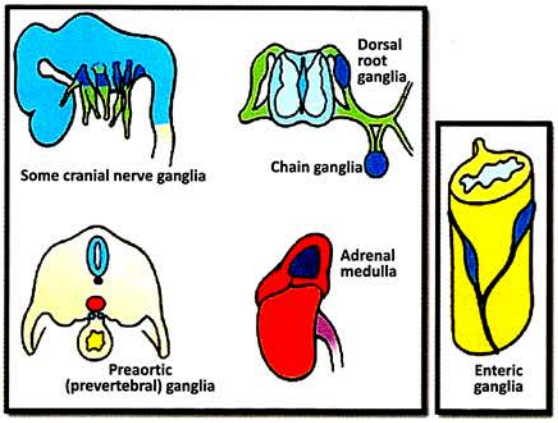
Neural crest cells forms the secondary mesoderm Skull bone (not necessarily all but it is mostly in the anterolateral area so posterior bones like occiptal bones comes from primary mesoderm).

Hence ,basically Primary mesoderm forms everything in body **except anterolateral area which is from neural crest cells, secondary mesoderm.**

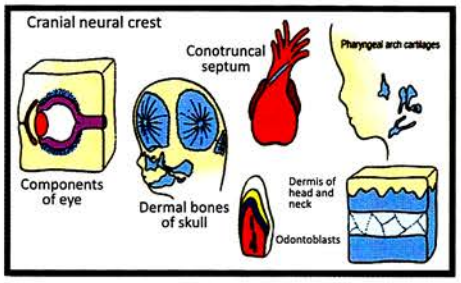
Secondary mesoderm form the pharyngeal arch bones **except pharyngeal arch muscles** .Pharyngeal arch muscle like Masseter are coming from the **primary mesoderm.**

Derivatives of neural crest cells

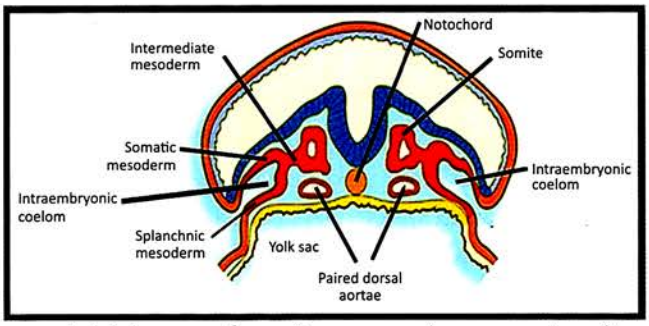
Neural crest cells are distributed throughout the body. They form the ganglia which can be **sympathetic** or **parasympathetic ganglia** (even the **dorsal root ganglia**). Pre-Aortic ganglia like celiac ganglia, mesenteric ganglia or even the adrenal medulla (has some sympathetic neurons). Most of the ganglia come **from Neural crest cells** contributing to peripheral nervous system.



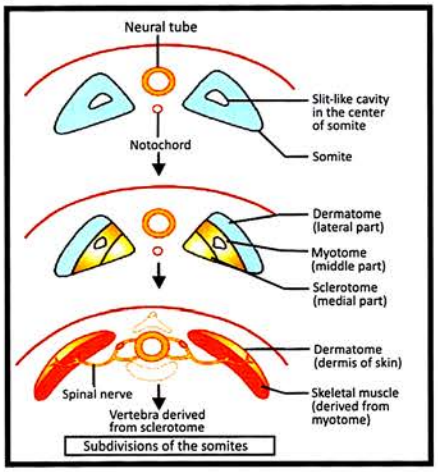
Most of **mesoderm of eyeball** come from **neural crest cells.** Most of **skull bones anterolateral** are coming from neural crest cells, **Aorto-pulomonary septum** developing heart is from neural crest cells, Neural crest cells is going to form **Malleus, incus, stapes, Mandible bone, Hyoid bones,** all in the pharyngeal arches and it is the mesenchyme region of head and neck region. In the anterolateral area ,**Epidermis come from surface ectoderm, Dermis is from neural crest cells. Teeth ondontoblast** form the dentine is from neural crest cells though the enamel which is superficial that will come from surface ectoderm. **Ameloblast** will form the enamel. Teeth as such are from the neural crest cells forming Odontoblast.



Mesoderm derivatives: In the given image ,we can see mesoderm derivatives in the transverse section of the embryo. There is **axial mesoderm which is notochord**. It is going to form the **nucleus pulposus** in the intervertebral disc later.

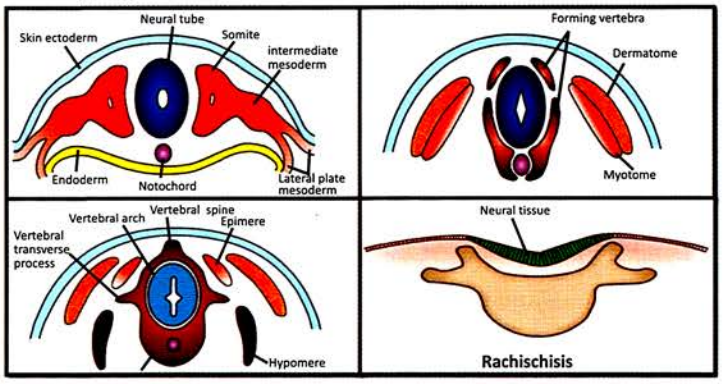


Para-axial mesoderm will form the somite.
The **intermediate mesoderm** will form the **kidney and ovary** i.e major portion of genito-urinary system.
The lateral plate mesoderm has two components
1. Dorsal somatic lateral plate mesoderm
2. Ventral Visceral lateral plate mesoderm
Dorsal somatic lateral plate mesoderm will form the **parietal layers of peritoneum, pleura, pericardium.** Whereas the **Ventral Visceral plate mesoderm/ splanchnic lateral plate mesoderm** is going to form the **visceral layers of peritoneum, pleura and pericardium.**
There are two cavities-**Amniotic cavity and yolk sac cavity** .A **third cavity** develops called the **Coelomic cavity** .This coelomic cavity **later forms three more cavity** which are the **pericardial, pleural and the peritoneal cavity.** These cavities are lined by membranes and those membranes are continued by lateral plate mesoderm. **Dorsal somatic lateral plate mesoderm is going to form Appendicular skeleton like humerus bone and femur bone** (skull bone from neural crest cells mostly and vertebrae from paraxial mesoderm).



Paraxial mesoderm is going to form the somite.
Somite has **three parts** and those three parts are called as
1) Lateral one : **Dermatome**
2) Middle one : **Myotome**
3) Medial one : **Sclerotome**
Sclerotome on each side forms **half of vertebrae** on each side which **fuse to form full vertebrae**. Myotome will form the **muscle** (Skeletal muscle mostly), Dermatome will form **dermis** (Skin).

Development of vertebrae -The given image shows developing vertebrae. Notochord which is the axial mesoderm **stimulate the ectoderm** to form the Nervous system. The **Neural tube later form the spinal cord**. The spinal cord is protected by Vertebrae. **Vertebrae is formed by the somite** which are divided into certain components, one of them is **sclerotome** .

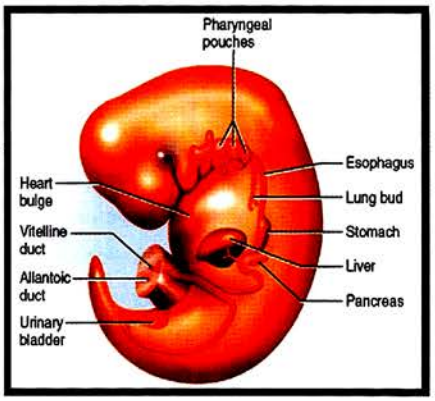


Sclerotome is of two types-
Dorsal & Ventral sclerotome.
Dorsal sclerotome fuse to form the spinal canal of vertebrae whereas **Body comes from the Ventral sclerotome.** **Notochord becomes the Nucleus pulposus** of the intervertebral disc. Sometimes **,neural tube is open which is called as Rachischisis** and CSF is coming out,even the vertebrae is open and spine is bifid ,that is problem of dorsal sclerotome not fusing and forming a Spina bifida along with Rachischisis.

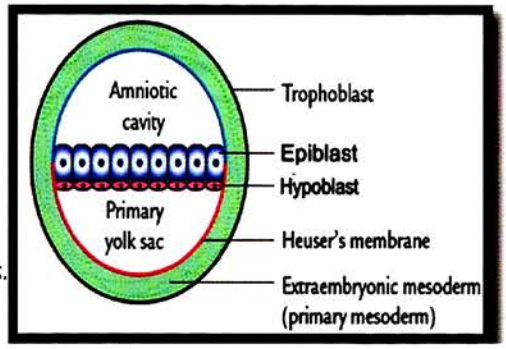
Most of the skull bone comes from **Neural Crest cells** (especially the **facial Skeleton, mandible, hyoid bone**). But **occipital bone** or the **vertebrae bone** comes from **somite (sclerotome portion)** or **para-axial mesoderm**. The **upper limb and lower limb** bones comes from **lateral plate mesoderm**, which has two components and is coming from the **dorsal somatic lateral plate mesoderm** forming **humerus bone, femur bone (appendicular skeleton).**

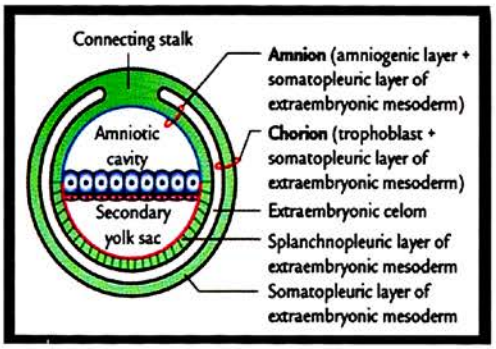
Endodermal derivatives

In the given image ,**Gut tube- comes from the endoderm** which have a foregut, midgut and hindgut as shown. **Hindgut diverticulum- Allantois** will enter the umbilical cord. **Midgut diverticulum- vitellointestinal duct** will enter the umbilical cord . **Foregut derivative ,Respiratory ,tube** Development of pharyngeal pouches in the lateral wall of pharynx, develop from the **endoderm of foregut** later forming glands like **thymus, parathyroid gland. Liver and pancreas** are developing at **junction of foregut and midgut** (also from the endoderm of foregut).
In the hindgut , develops **urogenital sinus** which will form **urinary bladder, Urethra and lower part of vagina** comes from the **endoderm of urogenital sinus** in the **lower part of hindgut (cloaca region).**



The given image shows **amniotic cavity dorsal** and the **yolk sac cavity ventral.**
Dorsal - Epiblast cells,
Ventral -Hypoblast cells.

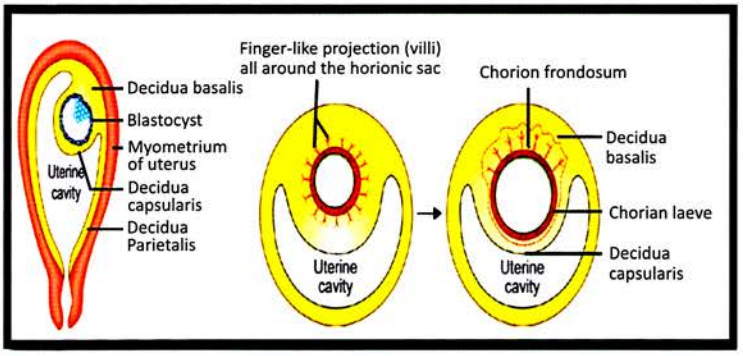




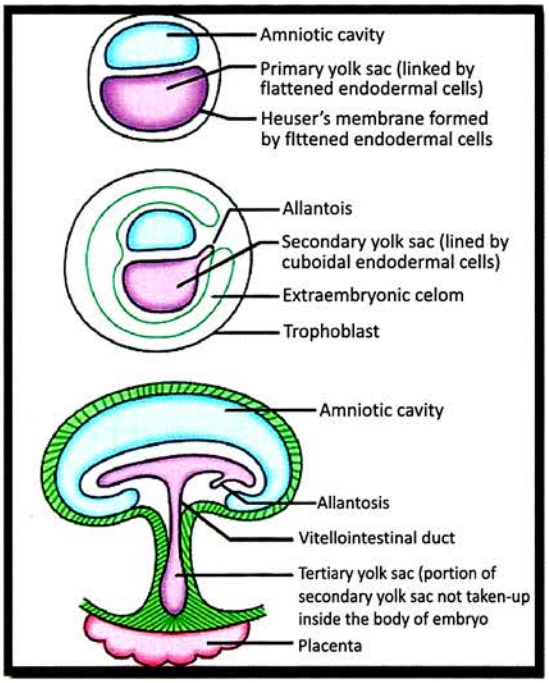
Extra-embryonic coelomic cavity

It is going to **divide** the extra-embryonic mesoderm into **two parts**. The extra embryonic mesoderm towards the yolk sac is called as **Splanchnopleuric** extra-embryonic mesoderm and then beyond that lines the amniotic cavity and outside called the **parietal extra embryonic mesoderm or also called somato-pleuric extraembryonic mesoderm.**

Between Somatopleuric-extraembryonic mesoderm and the visceral mesoderm is the **extra embryonic coelomic cavity.** The membrane called **chorion.** It is formed by **trophoblast** which is outside along with somatopleuric layer of extraembryonic mesoderm. Amnion-Lines the amniotic cavity ,formed from

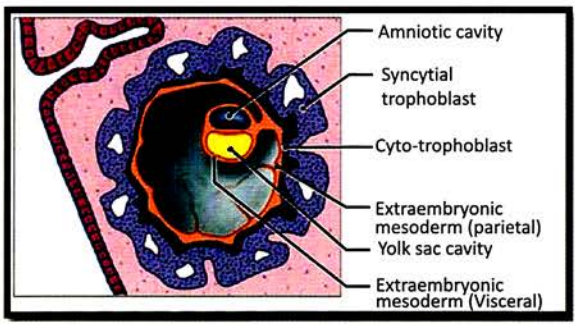


amniogenic cells lining amniotic cavity also the **somatopleuric extraembryonic mesoderm.** The **connecting stalk later becomes umbilical cord** components. In placenta formation – **Decidua basalis from the maternal side** (maternal placenta) and from the **fetal side it is the chorion frondosum.** Chorion frondosum comes from the **chorion** layer which develop some villi called **chorionic villi** and they will **penetrate into decidua basalis** of the maternal side. **Maternal placenta is decidua basalis** (endometrium of uterus) and **chorionic villi from fetal placenta component.**



In the beginning , we have **Primary yolk sac, Dorsal amniotic cavity** and **ventral yolk sac cavity** . Later it will become **secondary yolk sac** and then become **tertiary yolk sac.** Tertiary yolk sac communicate with midgut, foregut and hindgut **forming vitello-intestinal duct** which becomes content of umbilical cord. **Extra-embryonic coelomic cavity forming around the baby** ,there is **cephalo-caudal folding** of baby. The head comes towards the tail and in this process amniotic cavity surrounds the body of the baby all around. **Allantois is hindgut diverticulum** ,and the **vitellointestinal duct is midgut diverticulum** .Both will enter to become the umbilical cord contents.

Implantation

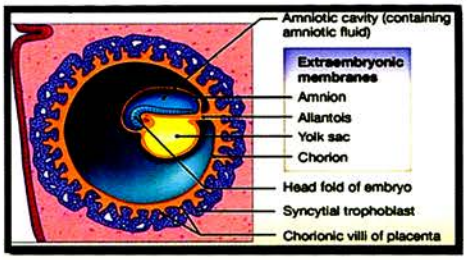


The given image shows baby implanted to the uterine **deciduas basalis**, with dorsal amniotic cavity and ventral yolk sac cavity with extra embryonic mesoderm.
Extra-embryonic mesoderm is formed from **Primary Umblical vesicle > the epiblast or the hypoblast or the trophoblast.**
If extra-embryonic mesoderm is around the yolk sac it is called as **splanchnic** and if it is around the amniotic cavity or periphery then it is called as the **parietal.** Parietal is towards the body wall (outside), and visceral towards the yolk sac. **Cytotrophoblast towards the baby and syncytiotrophoblast towards periphery.** Chorion is constituted by Syncytiotrophoblast and Cytotrophoblast.

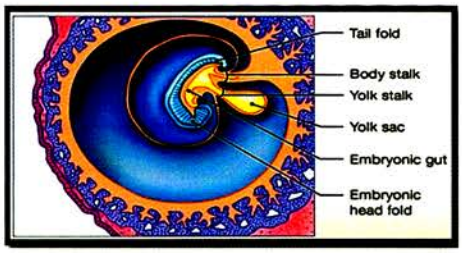
Extra-embryonic mesoderm which is Parietal (Chorion)
Amniongenic cell with some extra embryonic mesoderm (Parietal extra embryonic mesoderm) will make the amnion membrane lining the amniotic cavity.

Cephalo-caudal folding

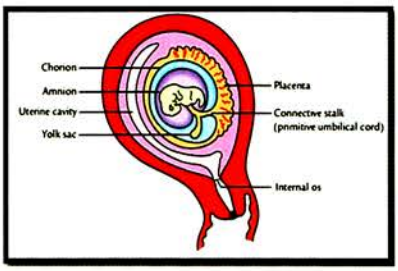
The above image shows fetus with Cephalo-caudal folding, head comes towards the tail. This amniotic cavity surrounds the fetus **and in that process , yolk sac is incorporated in to the fetus** to form the **gut tube** having foregut,midgut and hindgut.



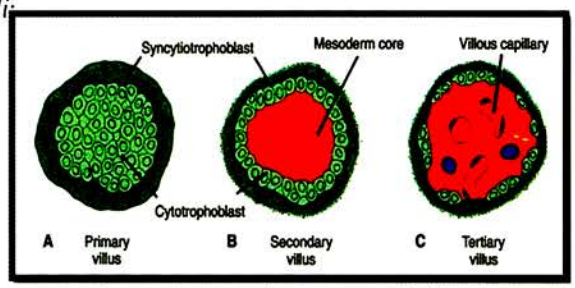
In the given image ,fetus is folding, amniotic cavity is surrounding the fetus and **yolk sac is communicating with midgut as vitello-intestinal duct** whereas the allantois is the hindgut diverticulum.



In the given image we see fetus with **connecting stalk** which **later becomes the umbilical cord** .Surrounding the fetus we can see amniotic cavity.
Placenta has two components :
Chorionic frondosum (From fetal placenta side) and there is **decidua basalis** (maternal side).

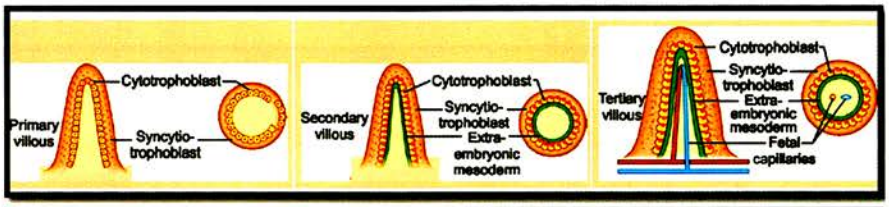


In the given image ,we can see there are three types of villi: Primary , secondary and tertiary villi.
1.Primary villi :
Cytotrophoblast + Synctiotrophoblast
2.Secondary Villi :
Cytotrophoblast + Synctiotrophoblast + Extra-embryonic mesoderm



3.Tertiary Villi : **Cytotrophoblast + Synctiotrophoblast + Extra-embryonic mesoderm + Fetal blood vessels**

In the given images , in **primary villus** we can notice there is **central Cytotrophoblast** and **periphery is syncytiotrophoblast.**



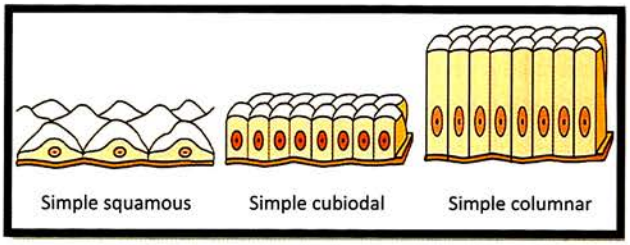
Primary villus	Secondary villus	Tertiary villus
Day 12	Day 13-15	Day 17-21 (week 3)
A core of cytotrophoblast cells covered by a layer of syncytium (syncytiotrophoblast)	Cytotrophoblast core invaded by extraembryonic mesoderm	Fetal blood invade the mesoderm

In **secondary villus** we see some **extra embryonic mesoderm** and as discussed before **blood vessels can be seen in tertiary villi (in 3rd week/day 17-21)**—During this time **fetal placental circulation** is also established ,(Uterine placental circulation is established during **Day11,12,13 post ovulation**)

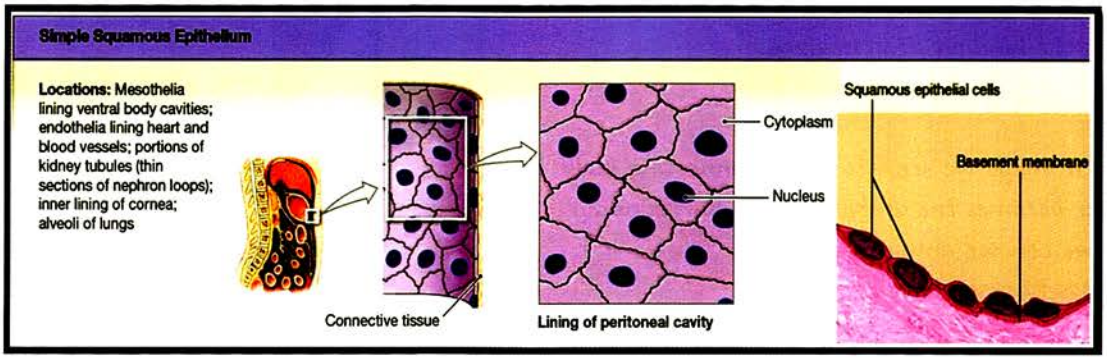
Histology

Types of simple epithelium

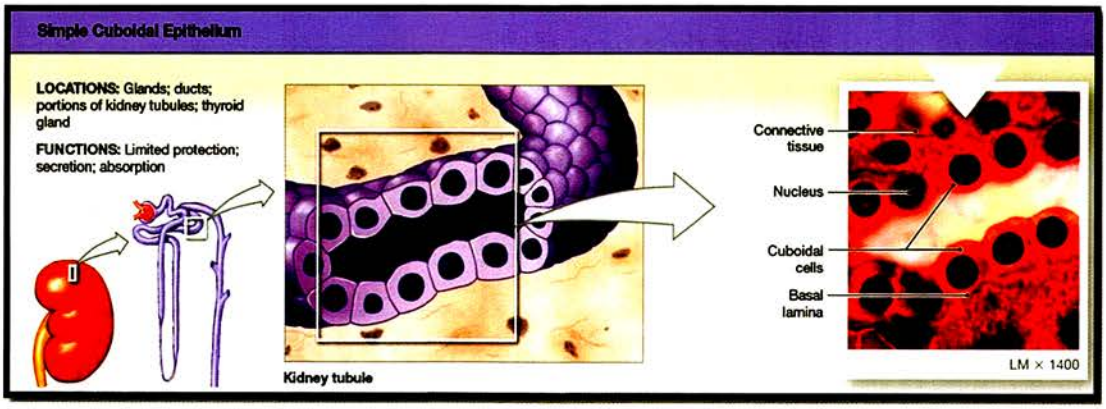
1. **Simple Squamous**
   Thin rim of cytoplasm above the nucleus
2. **Simple cuboidal**
   Height equal to breadth and central spherical nucleus
3. **Simple Columnar**
   Height is more than breadth, oval basal nuclei



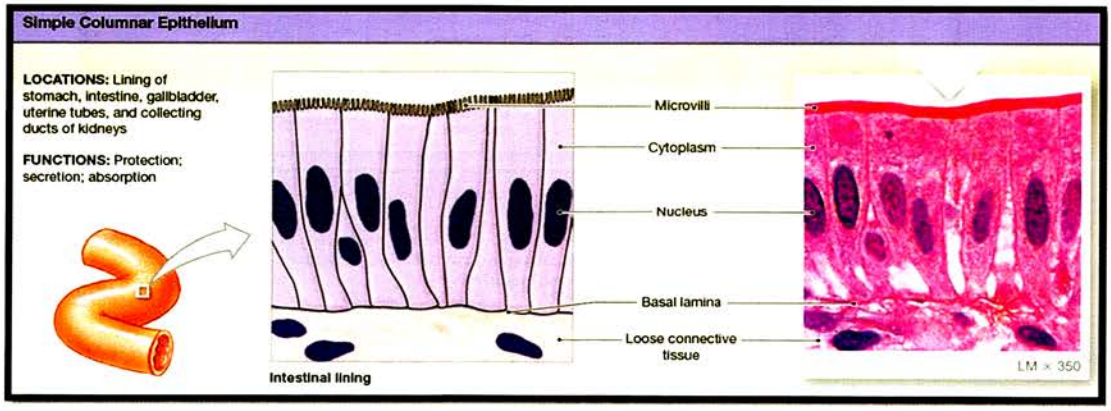
Simple Squamous Epithelium



Simple Cuboidal Epithelium



Simple Columnar Epithelium



Types of stratified epithelium

1.Pseudo-stratified Epithelium

Multiple levels of nuclei because cells are having different heights but it is not exactly stratified so called pseudo stratified columnar epithelium.

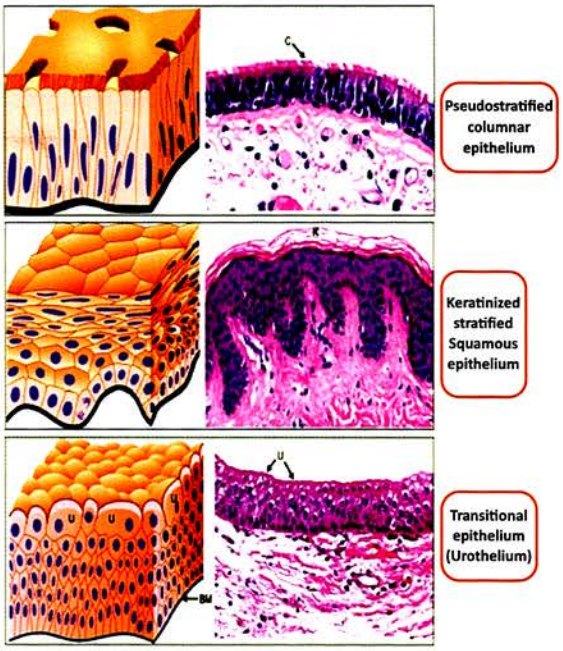
Seen in **Respiratory tubes, laryngeal part of Epiglottis.**

2. Keratinized-Stratified Squamous epithelium

There are **multiple levels of cell, basal cells are columnar**, then going up , there are **cuboidal cells** and superficial cells are **Squamous**. Seen in **skin**

3. Transitional epithelium

Appears like stratified, basal are columnar cells, going up we have cuboidal cells but the **superficial cells are large cells with two nuclei.** They are **large globular cells** (not flat squamous),these cells are also referred as **umbrella shaped cells**. Seen in **Urinary bladder, ureter.**

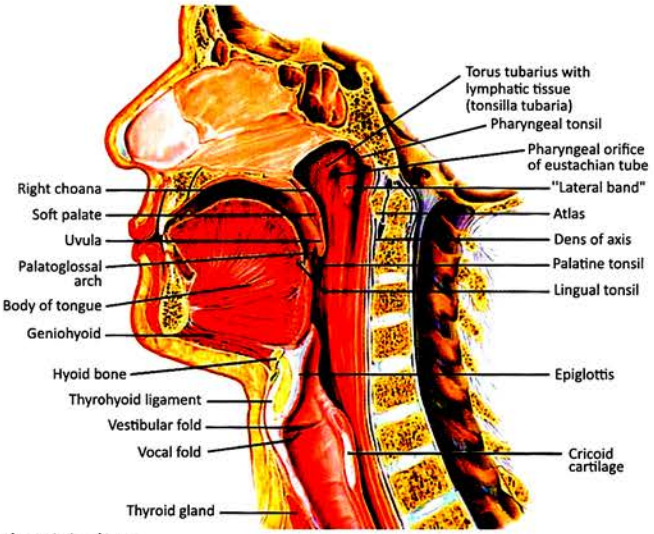


Types of epithelium in Head and Neck Region:

The image given shows the saggital section of Head and neck region to study various types of epithelium :-

1.Nasal Vestibule → Stratified Squamous epithelium (like skin with hair)

2.Respiratory tube → Respiratory epithelium (Except Epiglottis) → only laryngeal part of epiglottis is respiratory epithelium, not the lingual surface. **Lingual surface has** same epithelium as tongue or oral cavity (that is **stratified Squamous epithelium**)



Key note- **In dorsum of tongue or hard palate → keratinized epithelium**

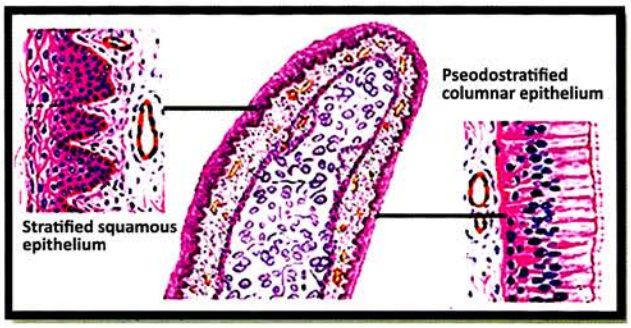
Ventral aspect of tongue/post. aspect → Non-keratinized Stratified Squamous epithelium.

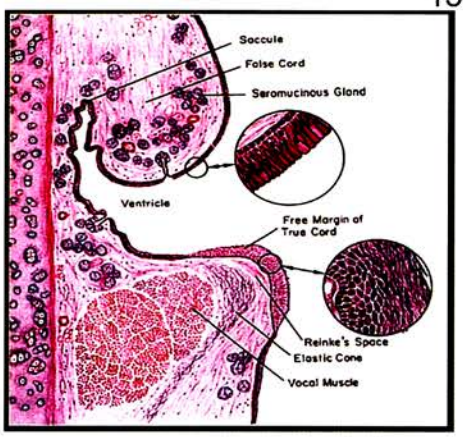
Non-keratinized Stratified Squamous epithelium is also present on the **soft palate, palatine tonsil, lingual surface of the epiglottis, vocal cord of larynx (otherwise respiratory tube, entire larynx is having respiratory epithelium i.e. Pseudostratified ciliated columnar epithelium).**

Epiglottis:

Epiglottis has oral surface towards the tongue and laryngeal surface towards the larynx.

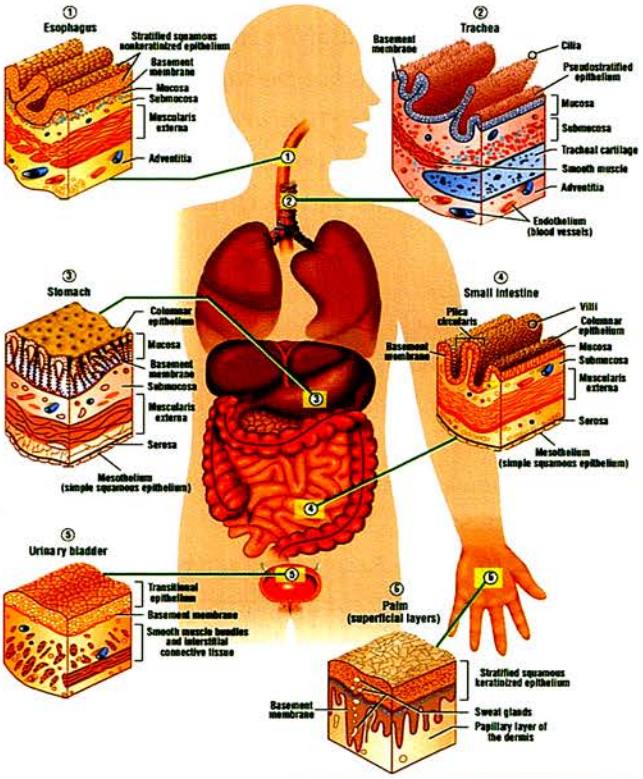
Oral surface: Stratified squamous non-keratinized epithelium. Laryngeal surface: Respiratory epithelium (Pseudo stratified ciliated columnar with goblet cells)





Larynx: *It shows* **hyaline cartilage with chondrocytes** *and the* **matrix** *has* **glassy appearance** *without the appearance of fibres and the epithelium is entirely* **Respiratory Epithelium except the vocal cord** *(because vocal cord are prone to abrasions by the fast moving air)*

" Vocal cords are Non-keratinized stratified Squamou epithelium to protect from the abrasions "



Various body tubes

1) Esophagus:- non-keratinized stratified Squamous epithelium

2) Intestine and Stomach :- Columnar Epithelium
In the stomach there are five types of cells which are forming the gastric gland components.

3) Respiratory tube :-Pseudostratified ciliated columnar epithelium with goblet cells.

4) Urinary bladder, Ureter :- Transitional epithelium

5) Skin, Oral cavity *(Hard palate, dorsum of tongue)* **: Stratified Squamous Keratinized epithelium**

6) Esophagus :- Stratified Squamous epithelium Glands.

Glands

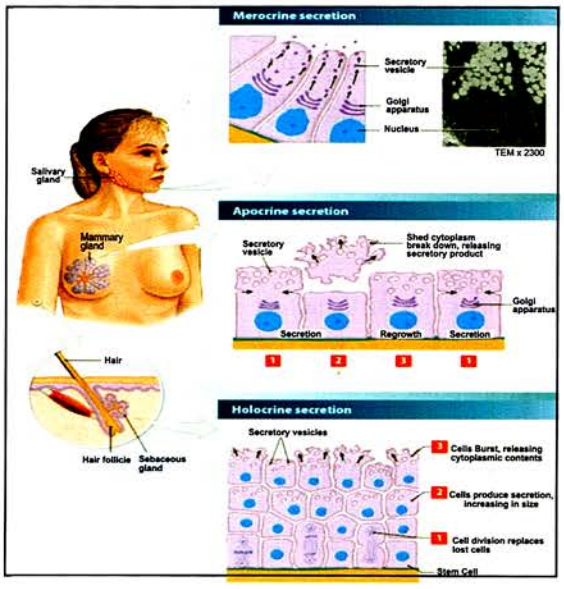
Three variety of glands

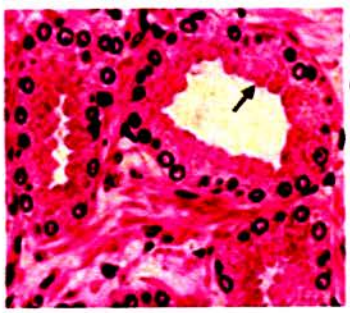
There are three variety of glands:

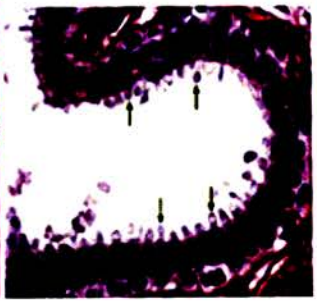
1.Merocrine/Eccrine Variety *: seen in* **Parotid** *gland,***Salivary** *glands,* **no loss of any cell membrane**

2. Apocrine Variety *: In* **Mammary gland(** *Modified sweat gland),in apocrine , apical portion of cell is broken and secretion covers the the membranes partly ,***there is apical loss of cell membrane**

3.Holocrine Variety: In Skin Sebaceous gland *,in holocrine entire cell membrane is lost ,***all the cells and organelle become secretion** *like sebum and the sebum is going along with the hair follicle.*







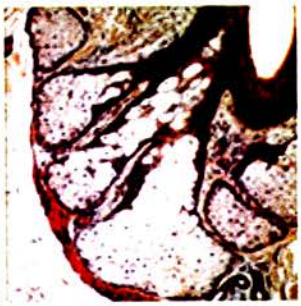
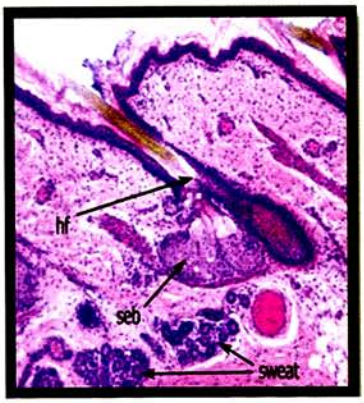


Fig 1- merocrine gland Fig 2- Apocrine gland Fig 3- Holocrine gland



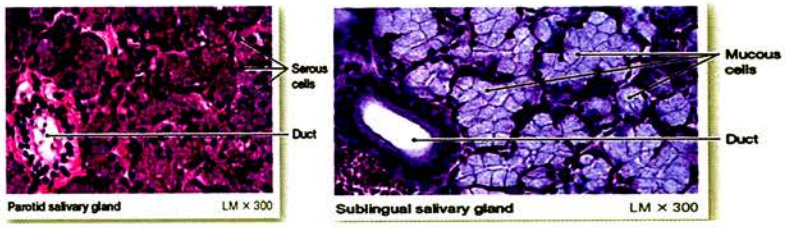
Skin with hair follicle :The given image shows skin with hair follicle and sebaceous gland

(How to identify Peripheral cells have intact cell membrane but towards the secretion duct part is getting disoluted or getting lost and coming out as secretions)

Classfication of glands:

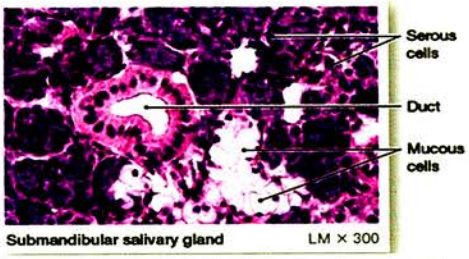
1) **Serous glands**-Parotid salivary glands
2) **Mucinous glands**- Sublingual glands
3) **Seromucinous glands**-submandibular glands (mixed salivary glands)

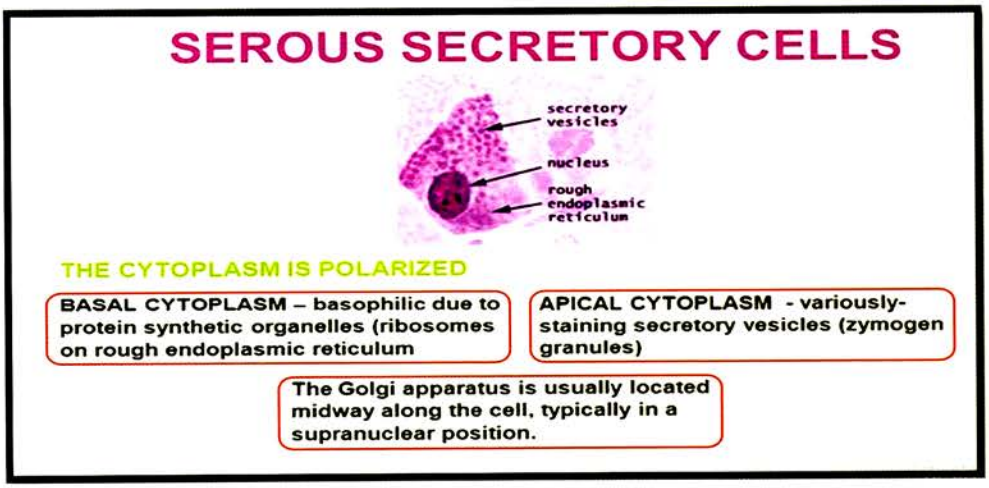
In seromucinous glands –we see Serous demilunes serous glands are sitting on the mucous gland



→ How to identify Mucous glands : they have empty look and light staining

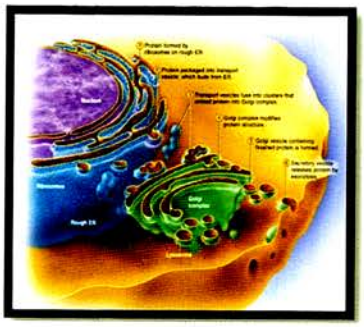
→ How to identify serous glands : Serous glands are dark staining cells

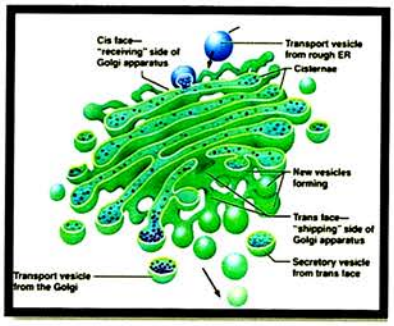




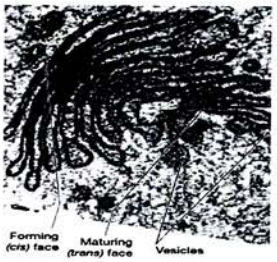
Cellular Structures

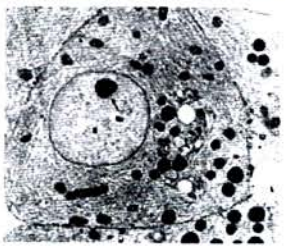
The given images shows **secretion by rough endoplasmic reticulum** packaged by the **golgi bodies** (which are supranuclear) ,the secretions are **sent out into the lumen** via **secretory vacuoles.**





In the image , the **golgi bodies has a receiving end and sending end.** It receives the packaging from the endoplasmic reticulum and then it will pack and **send towards the apical luminal surface.** Secretory vaculoes can be seen towards the lumen. Endoplasmic reticulumn seen towards the basal side of the cell,golgi bodies are seen supranuclear which produce secretions towards the lumen.





Skin Histology

The above image shows **5 layers of skin.** The layers are: (From **above to below**)

1.Stratum Corneum Has lot of **Keratin fibers** coming from the third layer

2.Stratum Lucidum Not seen always . It is only seen in **Thick skin** of palms and soles

3.Stratum granulosum have kerato-hyaline granules which are involved in **formation of keratin fibers**

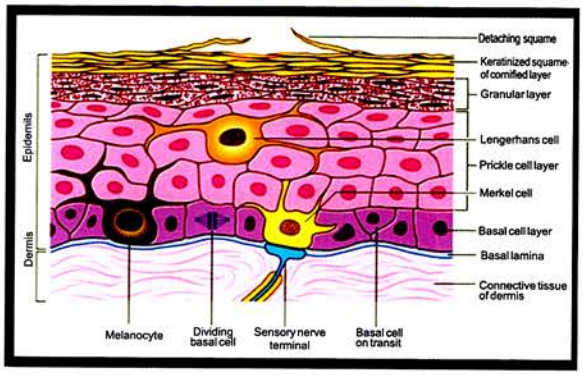
4. Stratum Spinosum Have desmosomes attached between the cells, have **spiny appearance**, this is the cortical cell layer

Applied- Desmosomes are broken in case of **pemphigus vulgaris (Intraepithelial lesion)** leading to skin blisters.

5. Stratum Basale

a) has **melanocytes** (from neural crest cells)**giving melanin**

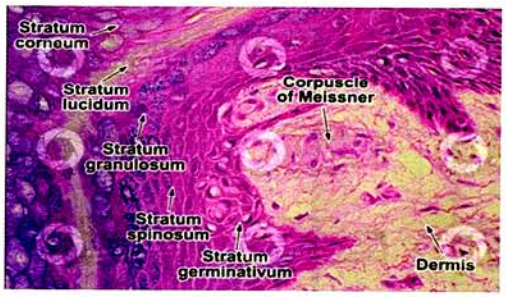
b) **hair** has **Merkel cell layer**, involved in **light touch sensation (Applied-Braile)**,it is a **slow adapting** cell and it **has stem cells** which add more layers of skin as skin disintegrate with time.

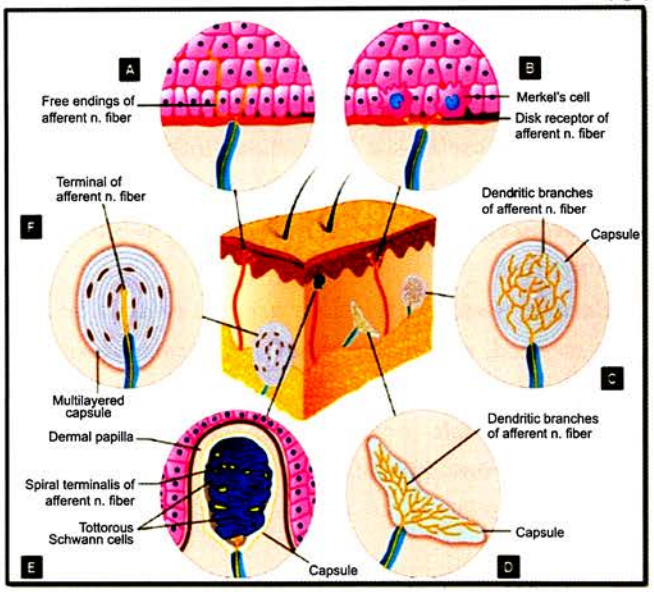


→ **"Langerhans cell (not in the basal layer) is the antigen presenting cell of the monocyte phagocytosis series,it picks up antigen from the skin and carry antigen towards lymph node)"**

→ **Deep to st.basale** is the **subepithelial connective tissue** which is **dermis.** In Dermis , we have meissner's corpuscle which help us in **detection of Braile.** It is a rapidly adapting receptor which help to read braile faster .

What to choose if both Merkel and Meissner are given in option to read Braile : Merkel > Meissener's .



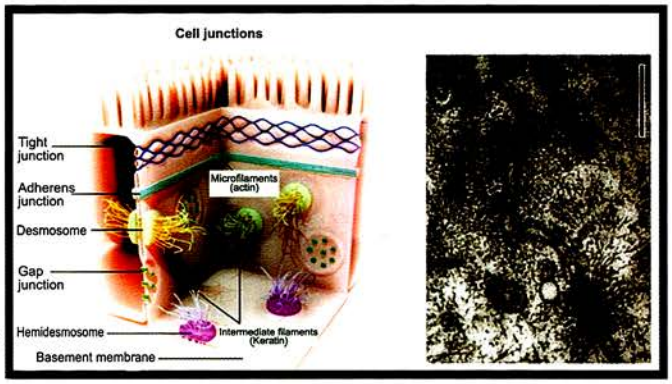


Comparison of Merkels vs Meisseners

In the image we can see that
Merkel cell : slowly adapting Receptor (better for reading braile)
Meissners corpuscle : Rapidly adapting receptor (poorly localizing).
Pacinian corpuscles : In deep dermis ,**carry the pressure & vibration**
Ruffini receptor : in deep dermis, detect **dermal stretch**, slowly adapting

Cell Junction

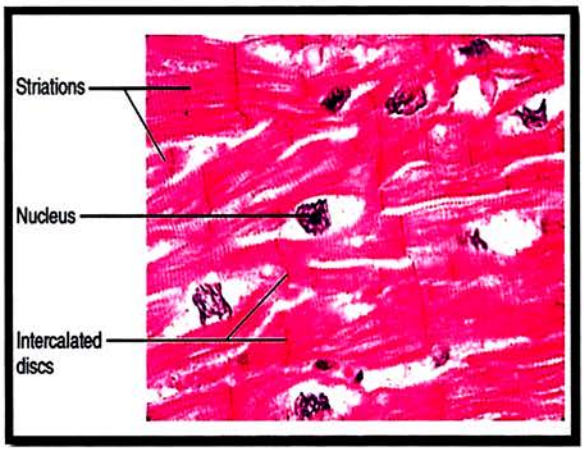
Towards the apical surface we have the **tight junction** also known as **zona occludens** ,under which we have the **zona adherens** as seen in the image followed by we have desmosomes called **Macula Adherens** and below that we have **gap junction** which is hexagonal nexus structure like tunnel between two cells for **free exchange** of molecules (like amino acids and glucose).
Below that we can also see **hemi-desmosomes** which attach cell to basement membrane .Hemidesmosomes have **integrins** as **cell adhesion molecule** .



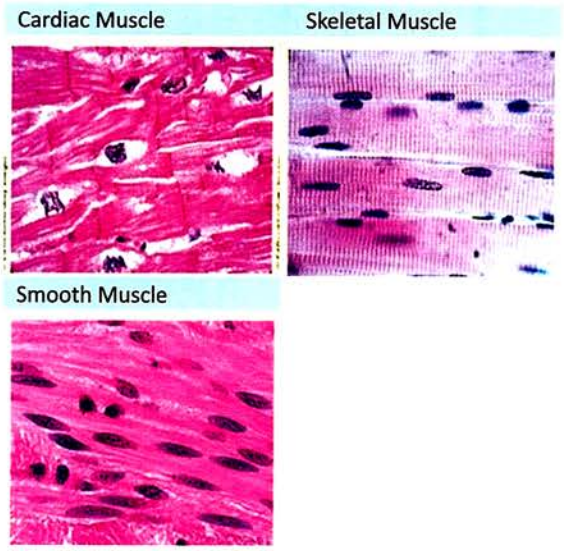
Applied- Damage of hemi-desmosome occur in Bullous Pemphigoid (sub-epithelial).
Key note-Desmosomes have **cadherins** which are damaged in **pemphigus vulgaris. (Intraepithelial lesions)**

Histology of cardiac muscle

The given image shows histology of cardiac muscle
It has Zona adherens, Macula Adherens, Gap Junction
(Gap junctions are important in intercalated disc between two cells, Gap junction works like a electrical synapse and allow the **transfer of ions** , it means if one cell is contracting simultaneously another cell should also be contracting, **if there is a problem with gap junction , it can lead to arrhythmia**)
→ **Tight junctions are absent in cardiac muscle.**



How we know it is cardiac muscle->**Nucleus with peri-nuclear halo, Presence of intercalated disc.**



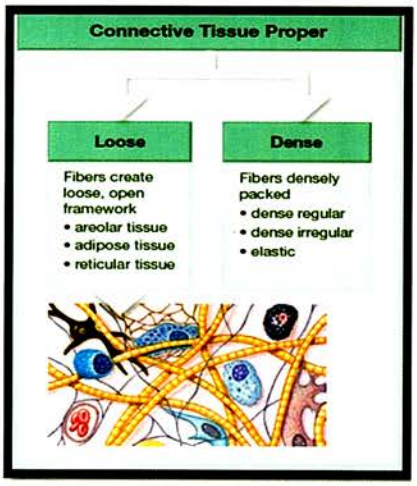
Comparison of Skeletal muscle vs Cardiac vs Smooth Muscle

1.Skeletal muscle is a **Syncytium** (due to loss of cell membrane) , long cells with **Multinucleated appearance**, deeply striated Z-band & I-Band are present

2.Cardiac muscle Striations are less evident or less striated, **peri-nuclear halo**, intercalated disc are present - these cells are branching cells

3.Smooth muscle are **spindle shaped cells**, entirely different from cardiac muscle or skeletal muscle.

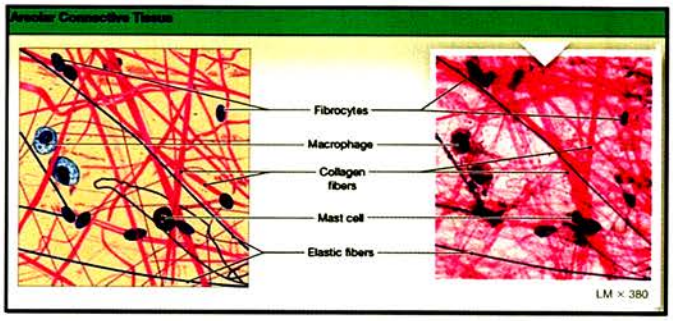
Connective Tissue



1) Loose areolar connective tissue seen in **lamina propria** (which is subepithelial connective tissue, also seen in superficial papillary layer of dermis)

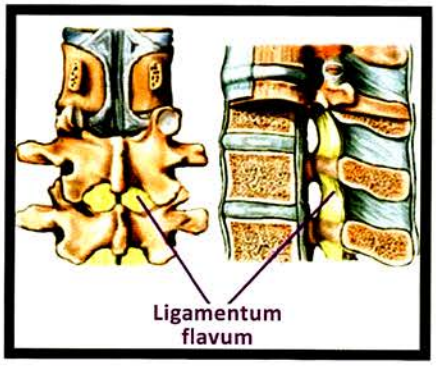
2) Dense connective tissue –it can be regular or irregular
Regular : Seen in **tendons ,ligaments**
Irregular : Seen in **deep irregular layer of dermis, periosteum , perichondrium.**

Loose areolar connective tissue-



There is less fibers, the fibers can be of three types
1. Collagen fibers
2. Elastic fibers
3. Reticular fibers (Rare)
How to identify collagen fibers –long wavy, running in bundles ,appear thick
(d/d Elastic fibres-single running thin fibers.)

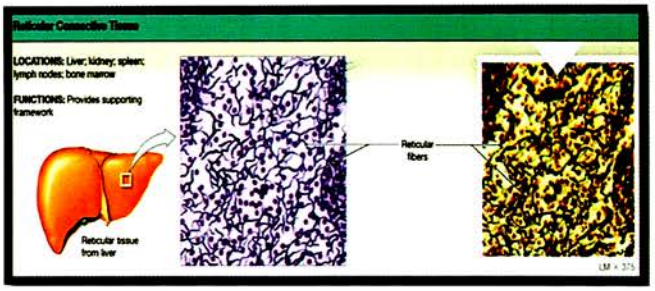
Ligamentum flavum :



Present in the vertebral canal, guarding the spinal cord running through the vertebral canal.
(80%elastic fibers, 20%collagen fibers)

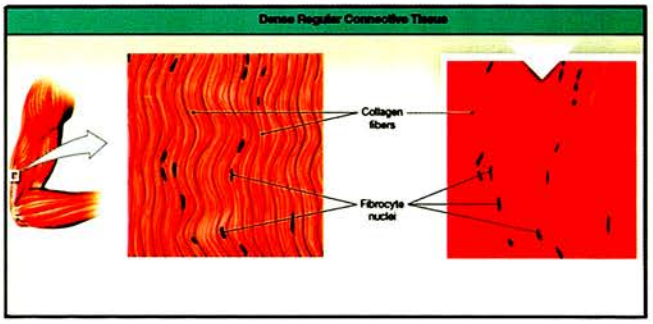
Reticular connective tissue –

Connective tissue present in liver, spleen, lymph-node organs **(except-Thymus)**. They are networking type of fibers and are thin branching type of fibers



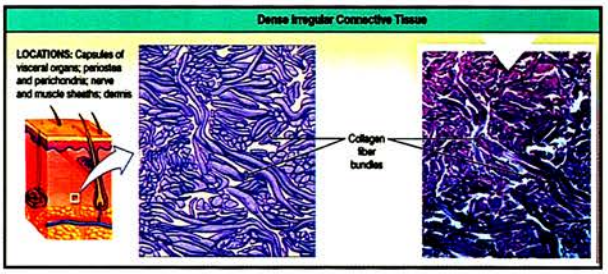
Dense Regular connective tissue –

seen in **tendons and ligaments** ,**thick wavy** fibers, running **parallel**



Dense irregular connective tissue-

Seen in Deep reticular layer of **epidermis or periosteum**, Perichondrium, collagen fibres run **irregularly**



Type	Location	Functions
I	Connective tissue of skin, bone, tendon, ligaments, dentin, sclera, fascia, and organ capsules (accounts for 90% of body collagen)	Provides resistance to force, tension, and stretch
II	Cartilage (hyaline and elastic), notochord, and intervertebral disc	Provides resistance to intermittent pressure
III	Prominent in loose connective tissue and organs (uterus, liver, spleen, kidney, lung, etc.), smooth muscle, endoneurium, blood vessels, and fetal skin	Forms reticular fibers, arranged as a loose meshwork of thin fibers, provides a supportive scaffolding for the specialized cells of various organs and blood vessels
IV	Basal laminae of epithelia, kidney glomeruli, and lens capsule	Provides support and filtration barrier

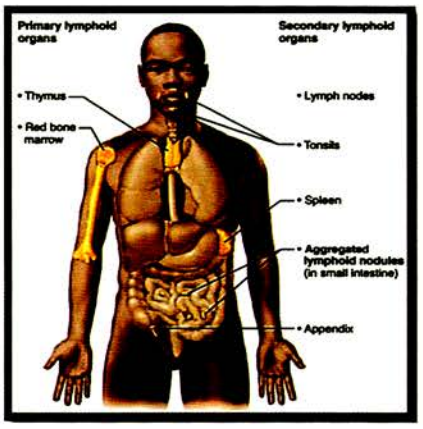
Key note- **Type 4 Collagen** gets damaged in **Alport syndrome**

Lymphoid organs

Classified as primary and secondary

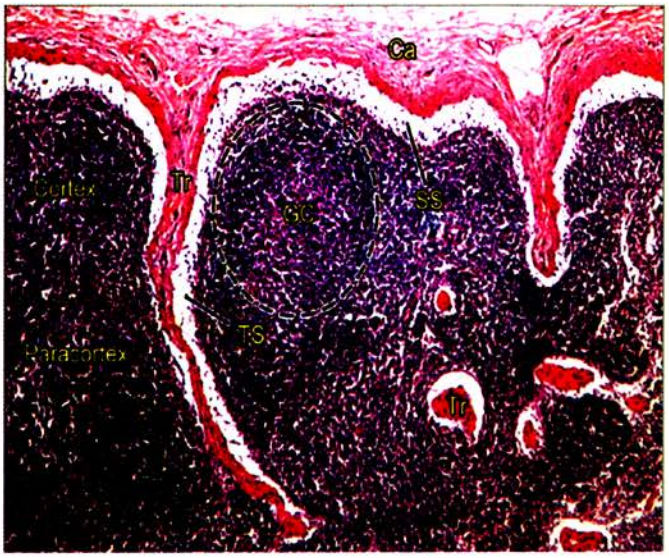
a. **Primary lymphoid organ** have stem cells like **bone marrow** and **thymus.**

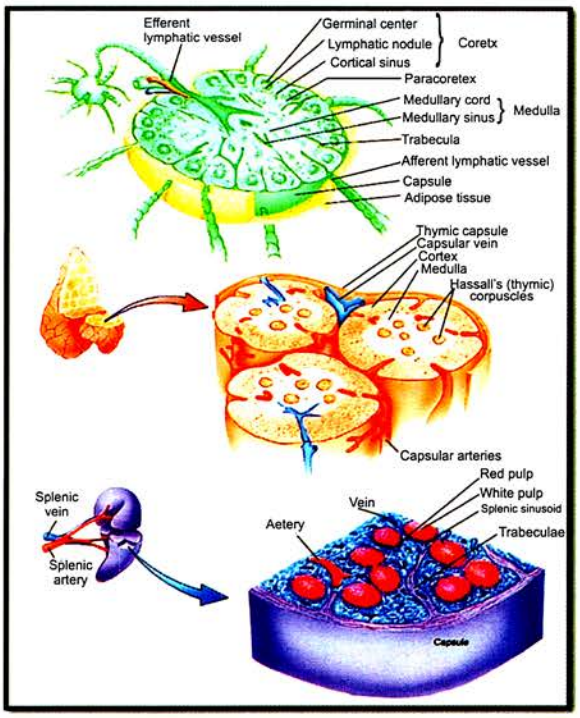
b. **Secondary Lymphoid organ do not have** stem cells,have **T And B lymphocytes** to mount the immune response
e.g **Lymph-node , tonsil,spleen or Peyer patches in terminal ileum.**



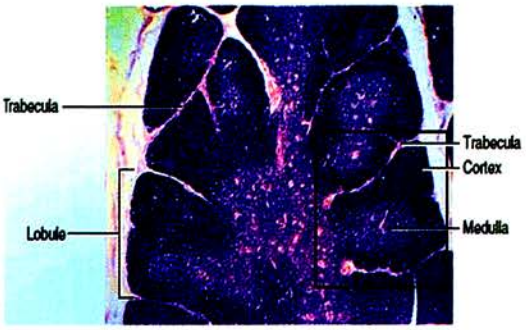
Lymph-node vs Thymus

1. **Lymph node has large sub-capsular sinus filled with lymph, has cortex, para-cortex and medulla.**

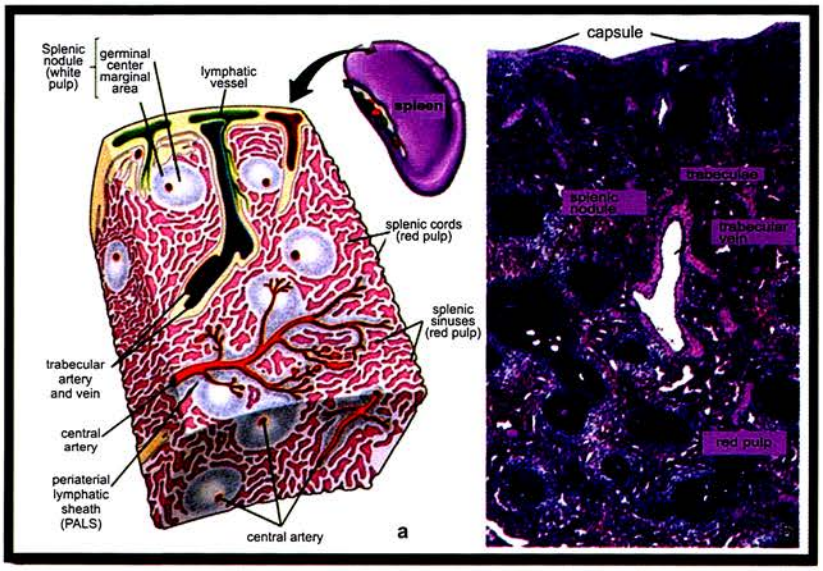




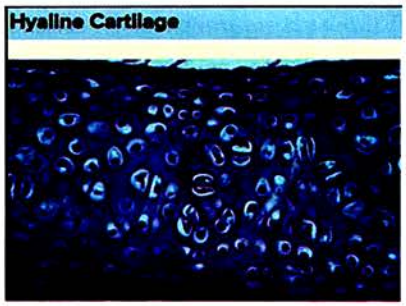
2. **Thymus Multiple lobules**, *separated by* **septa** *peripheral cortex , inside medulla (medulla contains* **Haasal's corpuscle**)



3. **Spleen** *contains* **red pulp** *and* **white Pulp**, *lymphoid nodules (which is the condensation of the WBC lymphocytes -white pulp, rest all is red pulp)*
Red pulp has two things
a). Splenic sinusoids *(RBC filled)*
b). Splenic cords of billroth (reticular tissue) in between.
Cords of bilroth enclose splenic sinusoids which are filled with lot of RBCs. **80% Spleen is Red pulp.**
What is White pulp ?- *it is the splenic nodules, has lymphocytes, has* **eccentric artery** *surrounded by* **Central arteriole** *with "***T-Lymphocytes called PALS-peri arterial lymphatic sheath surrounding the B-lymphocytes in germinal follicle***"(Lymphoid follicles are B-lymphocytes)*

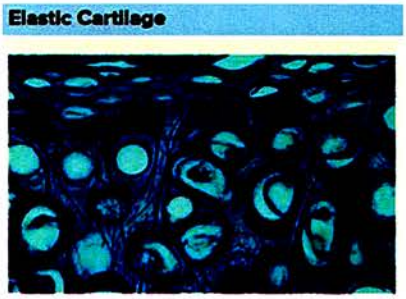


Key note- *Central artery is not in the center ,* **it is eccentric.**



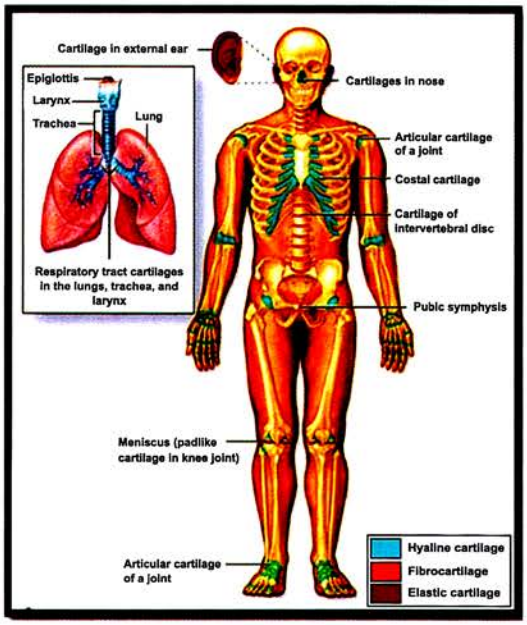
Cartilage-

1. **Hyaline Cartilage (more chondrocytes,less Collagen)** has hylous appearance of matrix, collagen fibers present **but not visible** because matrix has **same refractive index** as collagen fibers **also have bunches of chondrocytes.**



2. **Elastic Cartilage**
thin elastic fibers, singly running branching fibers along with chondrocytes

3. **Fibrocartilage**
Collagen fibers are visible, long wavy bundles, **rows of chondrocytes**



Most common type is hyaline cartilage, most of the Bones in body develop from hyaline cartilage **endochondral ossification**. Ribs develop from endochondral ossification of hyaline cartilage **but costal cartilage is hyaline cartilage.**
Articular cartilage is made of Hyaline cartilage.
Fibrocartilage->is shock absorber,found in the joints, Like intervertebral disc,knee meniscus,articular disc of Sterno-clavicular joint or Temporo-mandibular joint.

Elastic Cartilage-(E3)-1.E-External ear-pinna
2.E-eustachian tube
3.E-Epiglottis

Respiratory tube Histology:

Key note- Respiratory tube has Hyaline cartilage except epiglottis , which is elastic cartilage .
- it has Respiratory portion and conducting portion

a) **Respiratory portion starts with Respiratory Bronchiole.**
-Respiratory portion **has alveolar duct, alveolar Sac, alveoli.**

b) Conducting portion->Trachea to terminal bronchiole

Key points to Remember:

1 Bronchioles don't have hyaline cartilage it is replaced by Smooth muscle.

2. Smooth muscle is involved in Broncho-constriction and Bronchodilation.

3. Goblet cells are present till Bronchus.

4. Bronchioles don't have goblet cells.

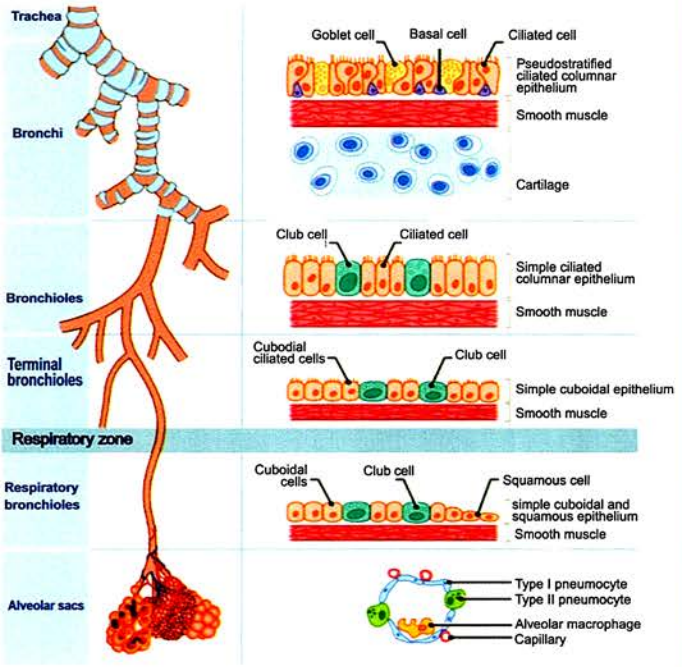
5. Epithelium→ in Beginning ,Pseudo-stratified ciliated Columnar Epithelium

→ Terminal Bronchiole, Respiratory bronchiole: Columnar changing to cuboidal

→ Bronchiole:

Type 1 pneumocytes : (Flat-squamous epithelium)

Type 2 pneumocytes:(Cuboidal cells, secrete Surfactant)



Bronchus-lumen

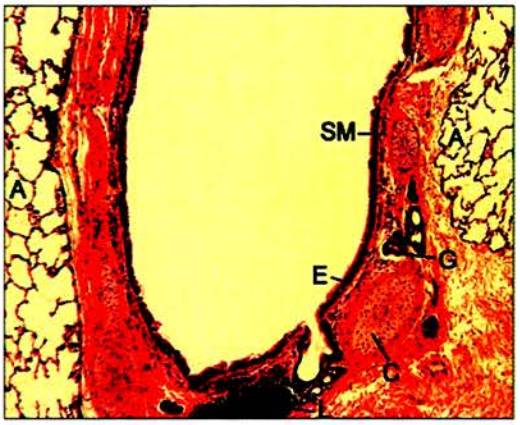
a) Ciliated Columnar epithelium

b) Hyaline Cartilage (More in Bronchus, Disappear at level of Bronchioles)

c) Smooth muscle (More in Bronchioles)

d) Type 1, Pneumocytes (Flat-squamous epithelium)

Dispersed Type 2 pneumocytes (Cuboidal cells, secrete Surfactant)



Oral Cavity, Esophagus and Stomach

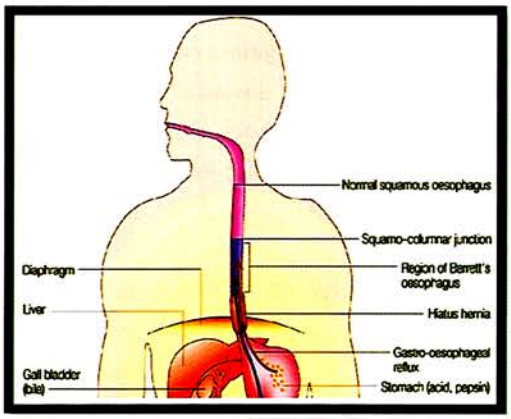
Pharynx, esophagus Non-Keratinized Stratified Squamous Epithelium

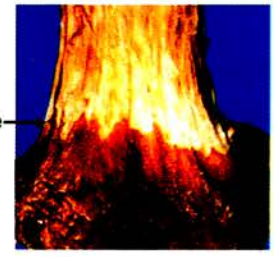
Stomach: Columnar epithelium

Applied at Sq-columnar junction Prone to metaplasia (GERD-Barrets esophagus) "Squamous replaced with Columnar"

Note:- Normally there is a Z-line (zig zag), 2 cm above Gastro-esophageal junction . In case of GERD , this line goes more proximal, the 2cm Z-line now becomes 5-6 cm .

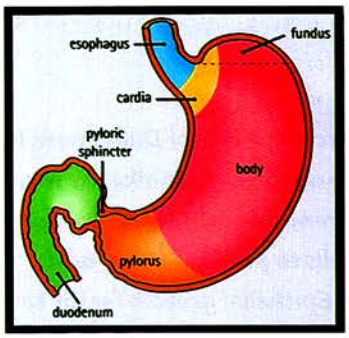
Sq-columnar junction is prone to cancer (Adenocarcinoma) in lower esophagus.





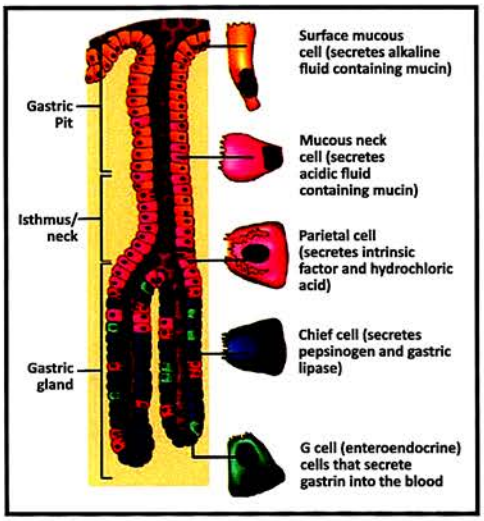
Stomach

Parietal Cell (also known as Oxyntic cell) Produce acid, produce intrinsic factor (Parietal cells are present more in fundus /body and less in Cardia)
Pylorus and Cardia has more of mucus cells to neutralize acid. And prevent acid moving into Esophagus and duodenum (can lead to ulceration)

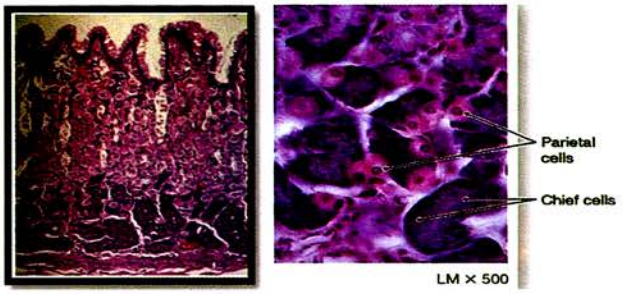


Stomach Histology

Upper half : **Mucus Cells/ Parietal cells**
Lower half **Chief Cells/entero-endocrine cells** (Fundus/ base of gastric gland)
Parietal cells: pink/eosinophilic (cuboidal cell with central spherical nuclei)
Chief cells : blue/basophilic,columnar with ovobasal nucleus with some zymogen granules (peptic enzymes)

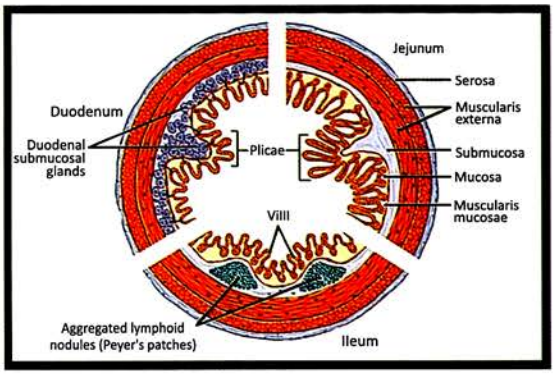


Superficially :- Pink cell or Parietal cells
Base Chief cells
Parietal cell give **fried egg appearance**



Key Points:

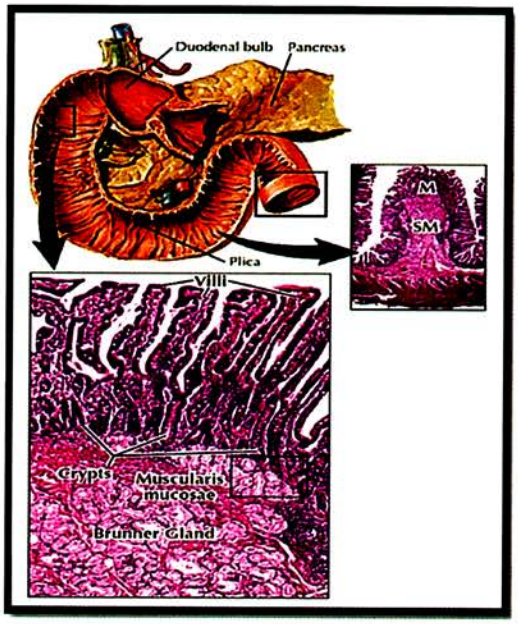
1. **Plicae Circulares, villi, microvilli** increase the surface area for absorption.
2. Plicae Circulares, villi, microvilli **absent in** stomach, And large instestine.
3. **Jejunum** has more of plicae circulares,villi and microvilli.
4. Plicae circulares,villi and microvilli are **reduced in** Duodenum, ileum.
5. **MALT is present in** Lamina propria (prominent in terminal ileum forming the **peyer's patches**)



- Duodenum: Brunner's glands (in Submucosa)
- Ileum: Peyer's patches (in lamina propria)
- Jejunum : Neither Brunner's; nor Peyer's

Brunner's gland

Proximal half of Duodenum has Brunner's gland.
Function **Create alkaline media, neutralize acid which come from stomach,secrete urogastrone (inhibit parietal cells to produce less of acid)**
- Epithelial growth factor to heal ulcer faster
Brunners glands are found **in sub-mucosa of GIT** in proximal Duodenum with micro-villi. Sub-mucosal glands are **also seen** In esophagus.



Small intestine has

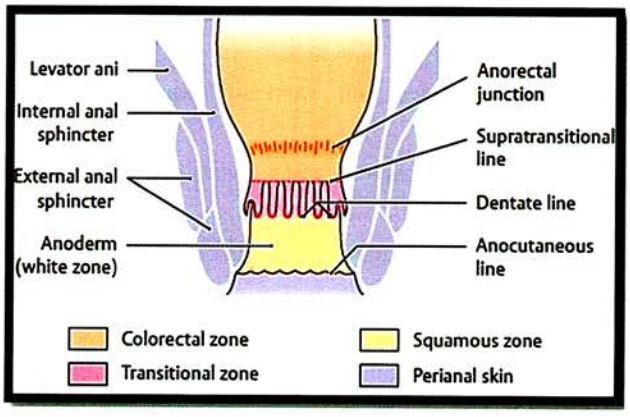
Enterocytes columnar cells for absorbtion,
Goblet cells empty appearance of mucus,
Paneth cells Towards the base of gland, apical eosinophilia
(**Why**-due to lysozymes taking lot of eosin, these cells give some cytokine like (TNF -α) Tissue necrotic factor alpha (to kill bacteria and protozoa)
Entero-endocrine cells Secrete endocrine hormones for absorption of food.

Large Intestine

Largest number of goblet cells (increase towards the Rectum and anal canal)
Anal canal has transition of 3 zones.

a) **Colorectal zone** Columnar Epithelium (like intestine)
b) **Anal zone** Cuboidal
c) **Squamous zone** Squamous

Squamous zone has a white line called- White line of hilton.
Above White line of Hilton->
Non Keratinized (no sweat and sebaceous glands)
Below White line of hilton Keratinized
(Like True skin-with sweat and sebaceous glands)



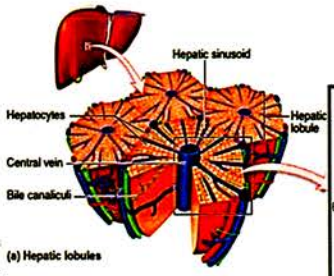
Liver Histology

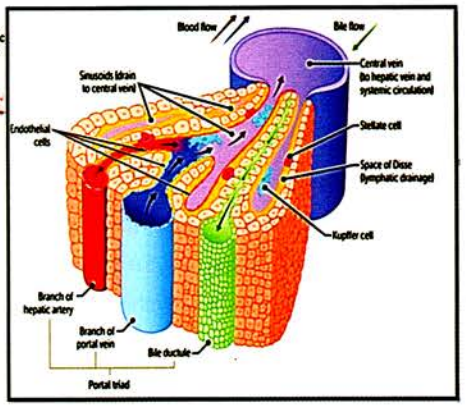
DAV Structures

Duct Bile Duct

Artery Hepatic Artery

Vein Portal Vein





Nutrients are absorbed from portal vein from Intestine and stomach carried to liver for metabolism, Nutrients reaching the hepatocytes are metabolized and pushed towards the **central vein.** From Central vein to **Hepatic vein** then to **Inferior vena cava** then to **Heart.**

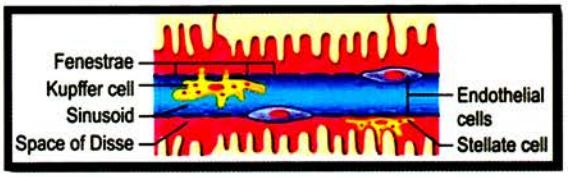
Liver requires oxygen which is given by Heart **via Hepatic Artery.**

Key Note-The ratio between two blood flow Hepatic Artery : Portal Vein = 20% : 80%.

Hepatic artery gives oxygen to Hepatocytes and the **carbon dioxide is given to liver sinusoids** which is **carried to Central vein** then to **Hepatic vein** then to **Inferior Vena cava** then to **Heart from where is pushed to Lung** for oxygenation.

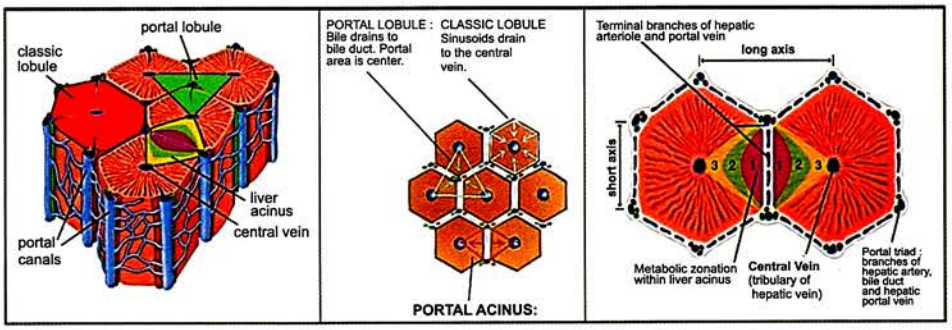
Hepatocytes also make bile, which is put **into Bile duct** (2nd part of duodenum),for emulsification and digestion of fat.

The magnified image of liver shows **perisinusiod space of disse**, inside sinusoids is the **kupffer** cells **(Modifed hepatocytes)**, perisinusoidal space have the **hepatic stellate cells of ITO.**



The given image shows liver sinusoid filled wth blood Which has **Kupffer cells which send pseudopodia** towards the hepatocytes in perisinusoidal space disse, which has **microvilli of hepatocytes**,filled with plasma with **fenestrated** endothelium.

Hepatic cells of ITO present in perisinusoidal space of disse, function- **absorption of vitamin A**, can also form fibers (Role in Liver Cirrhosis)



Units of liver

Hexagonal

(Old classical lobule)

-central vein in the center

↓

Triangular lobule

(Portal Lobule based upon Portal triad-

DAV-Duct,Artery,Vein at the center

↓

Functional lobule (liver/portal acinus)

DAV In center,

periphery more oxygenated (Area 1) — Central Least oxygenated area (Area 3)

Toxins least in Area 1 — Toxins more in Area 3

Kidney

There are two portions

a) Excretory (Nephron based)

b) Collecting portion -

→ Endothelium of glomerulus or bowmans Capsule or loop of henle : **Simple Squamous**

→ PCT, DCT **Cuboidal epithelium**

→ PCT has more microvilli so it becomes **striated** and DCT hs less microvilli so it is **non striated.**

→ Collecting ducts **columnar epithelium.**

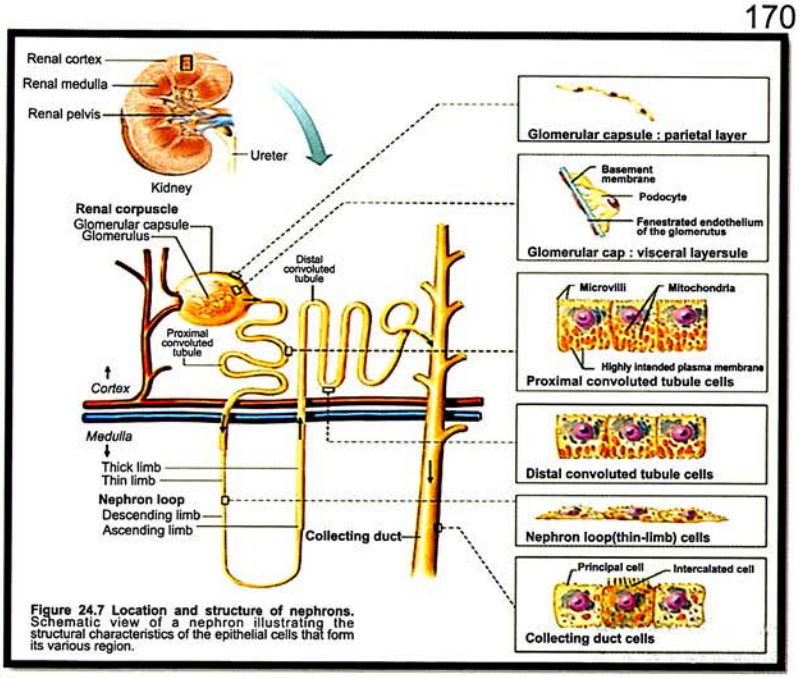
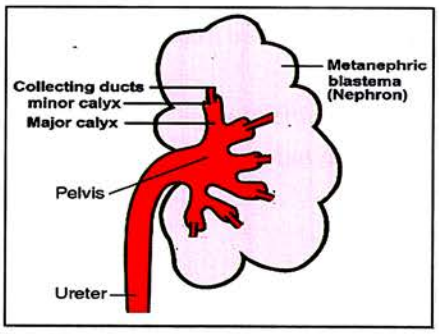
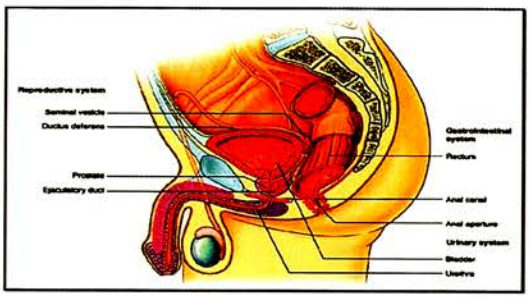


Figure 24.7 Location and structure of nephrons. Schematic view of a nephron illustrating the structural characteristics of the epithelial cells that form its various region.

Embryologically , Nephron part (Metanephric) forms the urine. **Collecting part is coming from uretric bud**. Ureter,Renal pelvis,major and minor calyx and the collecting ducts are lined by **transitional epithelium. Transitional epithelium begins at the tip of collecting duct because major lining of collecting duct is Columnar epithelium.**



Ureter,urinary bladderand proximal half of prostatic urethra Is Transitional epithelium but most of male urethra is Stratified -columnar epithelium **except at the tip which is Stratified – squamous epithelium**

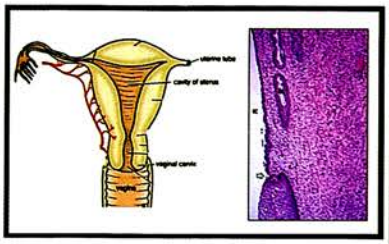


Male Reproductive Histology

In testis ,**blood testis barrier** is made by **sustentacular cells Of the sertoli,**

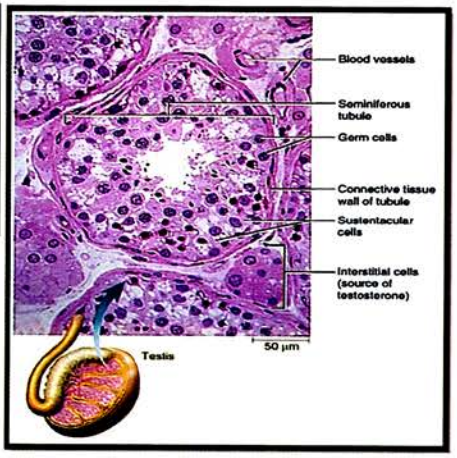
1.**Sertoli cells** : give hormones (**Mullerian inhibiting factor**)

2.**Interstitial Cells of leydig** : **Testosterone**



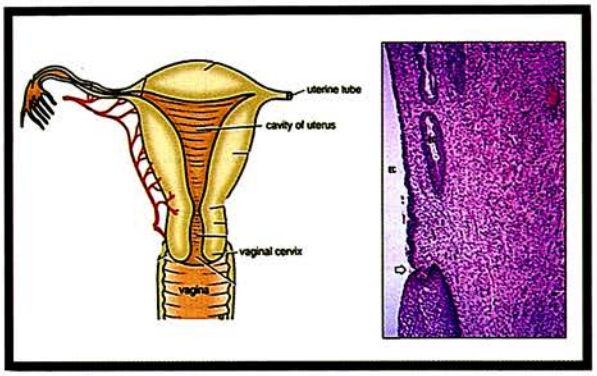
Sperms are in the lumen of seminiferous tubules and blood vessels are in the periphery,blood vessels or blood cells should not be exposed to sperm otherwise it can lead to antisperm antibody formation.

Primordial germ cells are forming the spermatogonia, gametocytes.



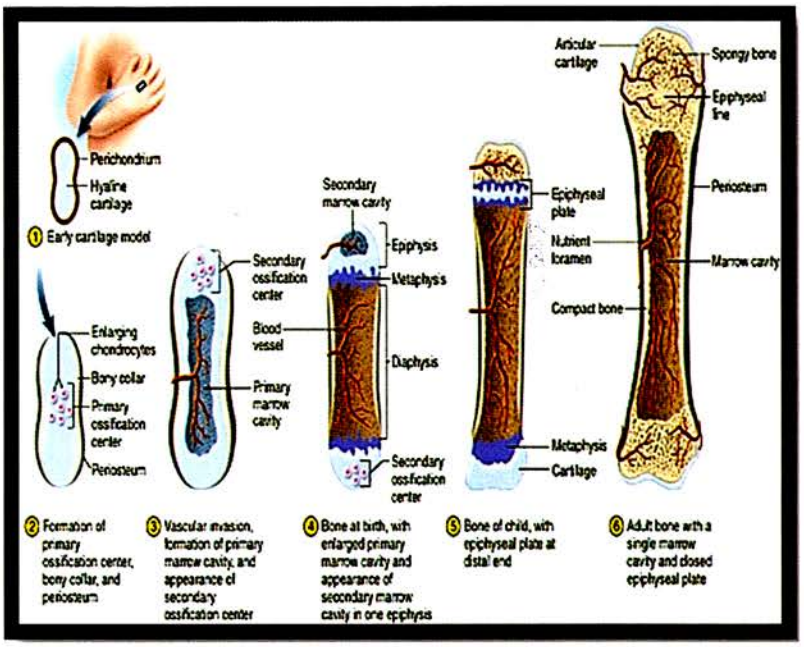
Female Reproductive Histology

Uterine tube Ciliated columnar epithelium
Uterus Columnar epithelium
Endocervix Columnar Epithelium
Ectocervix Stratified squamous non-keratinized (like vagina)
Squamo Columnar junction present between endocervix and ectocervix junction. This junction should be monitored, prone to dysplasia can lead to cancer.



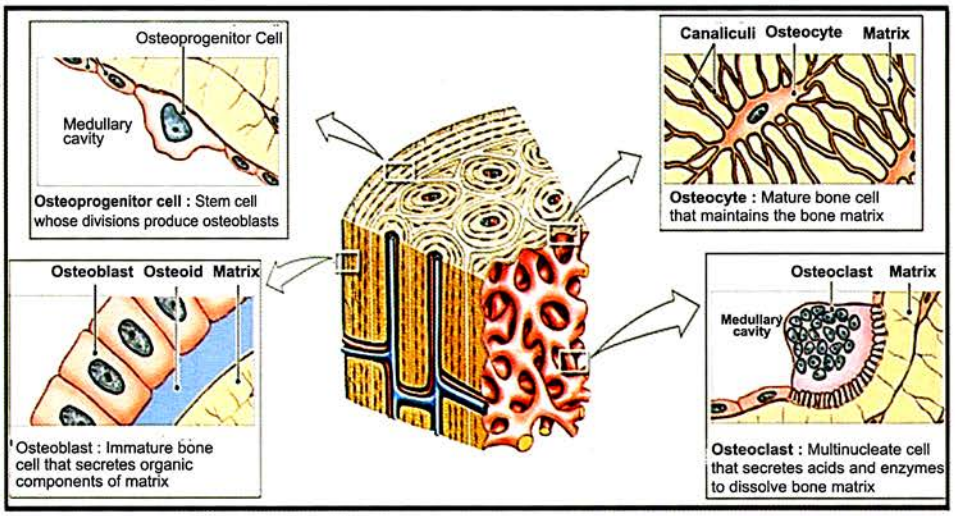
Development of Bone

Most of the bone develop in endochondral ossification in fetal cartilage which is hyaline cartilage . Primary center of ossification 6-8 week (intrauterine life) formed by osteocytes in diaphysis of bone. Secondary ossfication center is formed after birth which forms the Epiphysis of bone. Growth plate is replaced to metaphysis later. Ends of bone have articular cartilage which is hyaline type and helps in smooth movements in synovial joint.



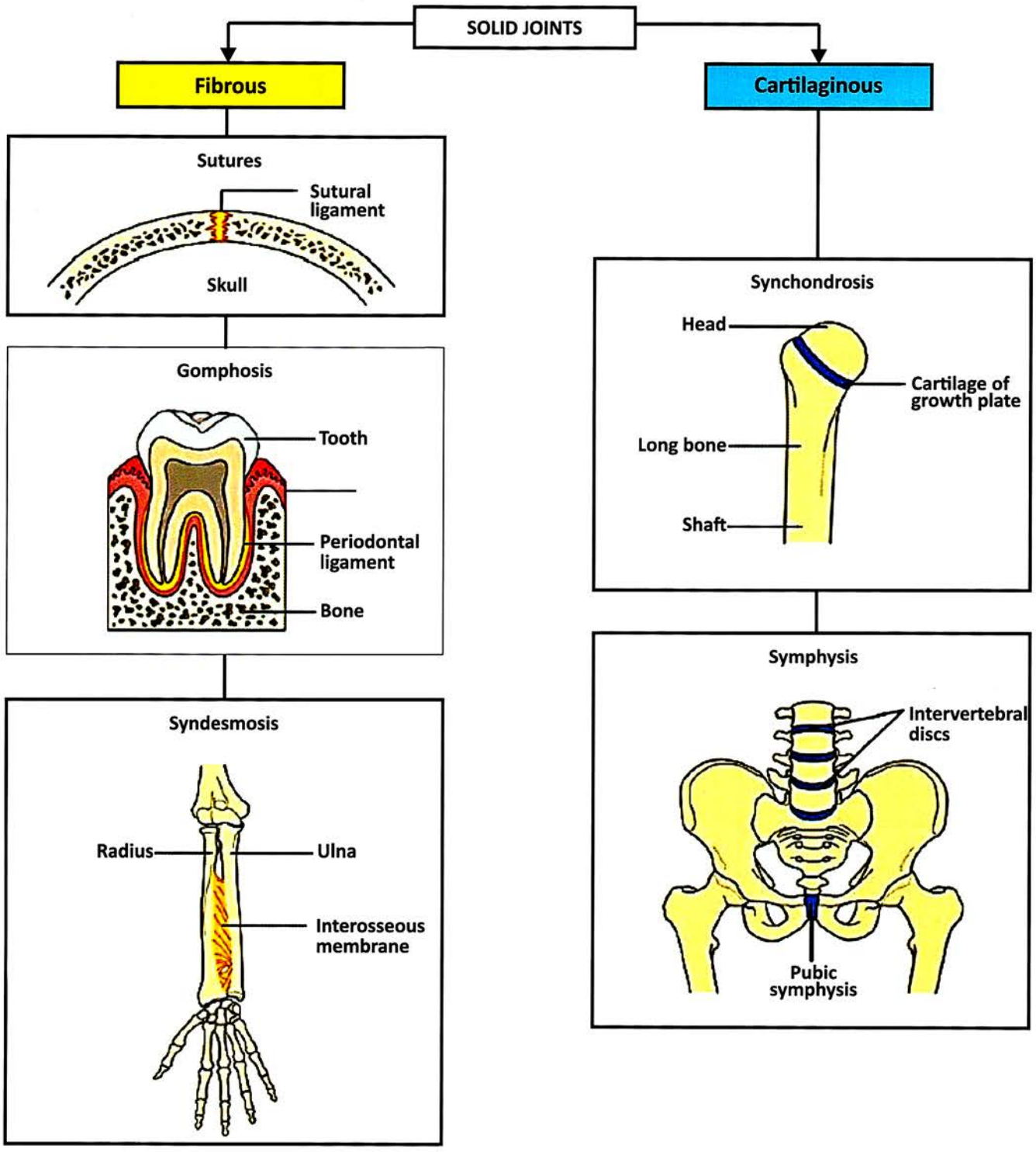
Haversian Canal

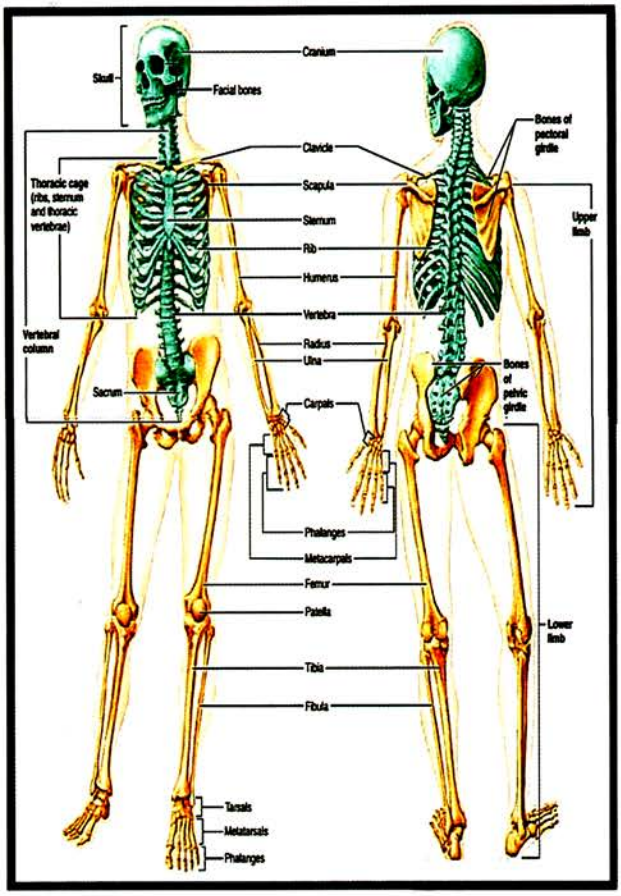
Osteon is unit of bone which has Haversian canal, **carry Neurovascular bundle.** Connected horizontally called **Volksmann's canal.** **Concentric lamelle** has some bone cells. **Osteoprogenitor Cell** are pleuripotent cell and it forms **osteoblast.** Osteoblast is involved in **bone formation** and when it **becomes old** it becomes **osteocyte.**



Osteoclast cell (**monocytes** coming together) →
->is a **multinucleated** cell,**bone eating** cell
(eat bone for remodelling of bone)

Joints:


SOLID JOINTS
Fibrous
Cartilaginous
Sutures
Sutural ligament
Skull
Gomphosis
Tooth
Periodontal ligament
Bone
Syndesmosis
Radius
Ulna
Interosseous membrane
Synchondrosis
Head
Cartilage of growth plate
Long bone
Shaft
Symphysis
Intervertebral discs
Pubic symphysis



Synovial Joint:

Atlanto-occipital joint **(ellipsoid)** yes movements

Atlanto-axial jointsNo movements joint (**Pivot joint**)

Other **elipsoid joint**-Wrist joint (radiocarpal), metacarpo phalangeal (What to answer if condylar is also in option **Ellipsoid>Condylar**)

Condylar jointsTM joint,knee joint

joint (**Condylar>Modified hinge**)

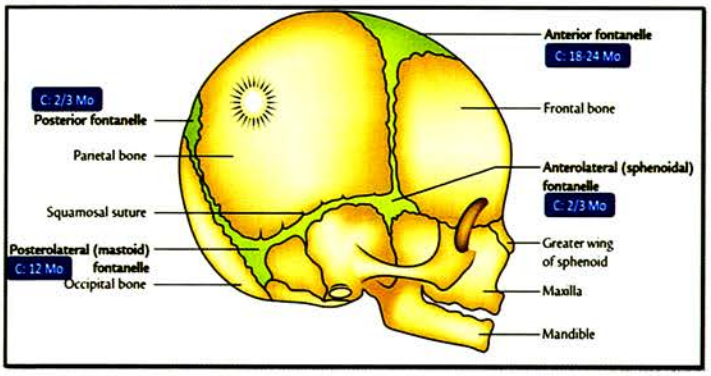
Saddle synovial joints-Malleus,incus,sternoclavicular, 1st mcp,Calcaneocuboid joint in foot

Ball and socket incus-stapes joint ,shoulder,hip joint, and Talocalcaneonavicular joint.

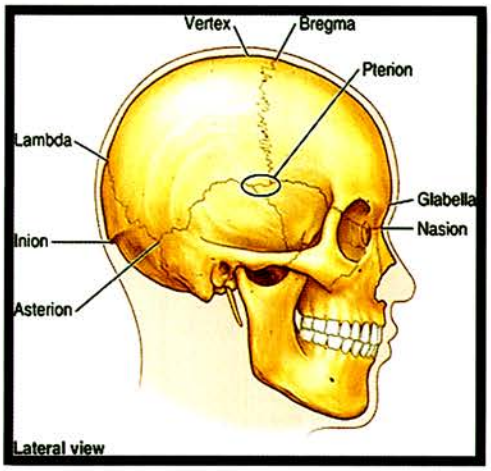
Neuro-Anatomy

Skull Development

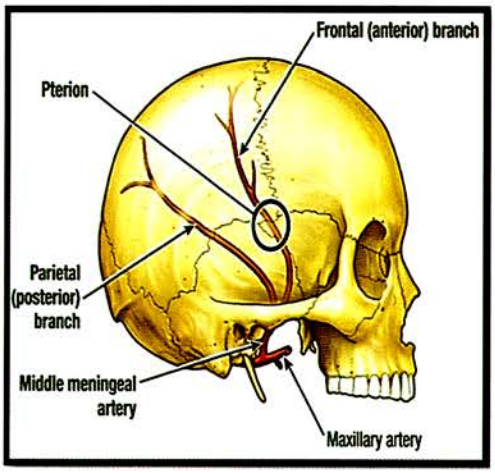
Key Note- Ant Fontanelle is **last to disappear**
Ant fontanells-> Development of **Bregma** suture
Post Fontanelle Development of **Lambda** suture
Post lateral fontanelle-> Development of **asterion**
Ant-lateral fontanelle Development of **Pterion**
(H-shaped suture where four bones meet)



Various Points in Adult Skull

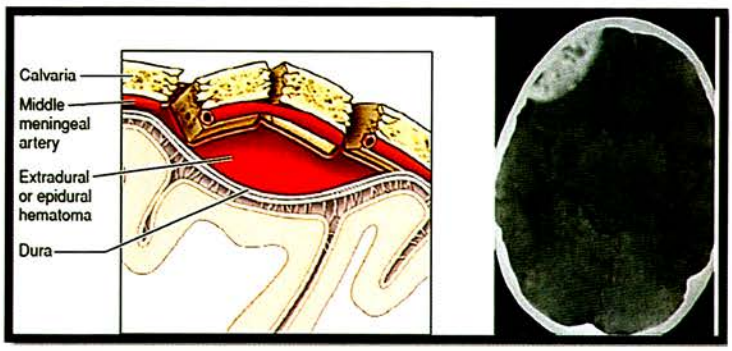


Maxillary artery branch of external carotid artery supply the maxilla bone, first part of maxillary artery gives branch Middle meningeal artery passing through foramen spinosum at the floor of the middle cranial fossa and enter the cranial cavity and divide into ant-post.
Ant division of Middle Meningeal artery passes through the Pterion. Pterion is a weak point prone to accident which can lead to **extra dural hemorrhage a/k Epidural hemorrhage.**

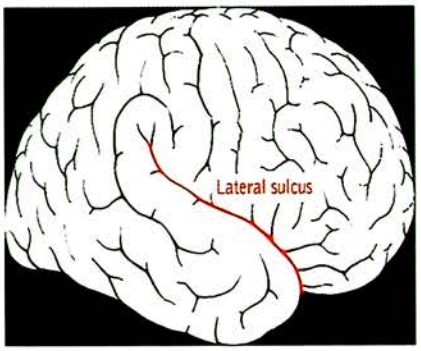


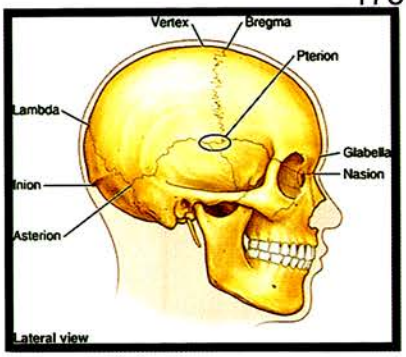
Findings On CT scan in extra dural hemorrhage

Bi-convex shadow (Omnious sign)
Management- Evacuation of hematoma



Pterion is also known as **Sylvian point** because it is the beginning of the stem of the lateral sulcus on cerebrum.





Comparison of skull

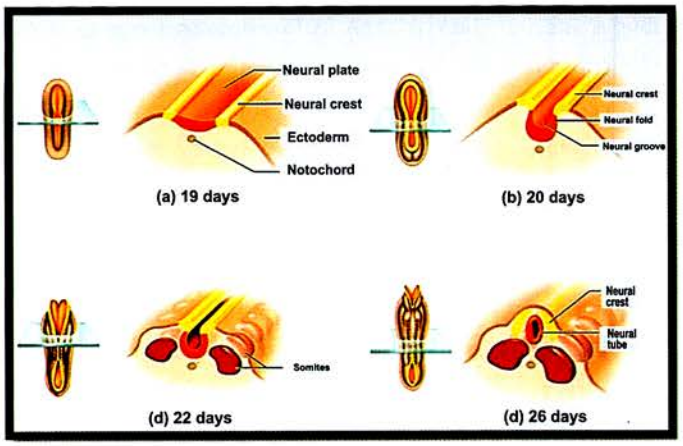
Structures at adult size (at birth)	Structures not at adult size (at birth)
▪ Tympanic membrane ▪ Tympanic cavity ▪ Ear ossicles (malleus, incus and stapes) ▪ Tympanic (mastoid. antrum ▪ Internal ear: Cochlea, vestibule, semicircular canal	▪ Tegmen tympani ▪ Mastoid process ▪ External ear and external auditory canal ▪ Eustachian tube

Nervous system Development

At the dorsum of baby a plate develops called Neural plate.Neural plate will develop to form neural groove and later neural tube.Two neural pores are formed: Cranial and caudal neuropore

Cranial Neuropore closure –At day 25 (Leading to formation of brain)

Caudal Neuropore closure At day 28 (Leading to formation of spinal cord)



Cut section of developing brain:

Notochord **stimulates overlying ectoderm** to form neural plate ectoderm. Neural plate ectoderm will form neural groove and neural tube.Neural groove **detach themselves to form Neural tube.**Neural tube in cranial part form the brain and caudal part will form the Spinal cord.**For Peripheral nervous system Neural crest cells** detach themselves from the dorsal side (periphery) and lie on the dorso lateral to neural tube and form **dorsal root ganglia.**It can be **symphatetic** and **parasympathetic ganglia. Preaortic and paraaortic** ganglia come from neural crest cells.**Sometimes Cranial and caudal neuropore donot close leading to open Neural tube defects.**

If Ant neuropore donot close : Anencephaly

If Post Neuropore donot close : Rachischisis

Anencephaly

Brain is small and degenerated without the skull cap.

Rachischisis

Defect in lumbo-sacral region, skin is missing, vertebrae is missing,Leakage of CSF.

Cranio-rachischisis-

Both defect together.

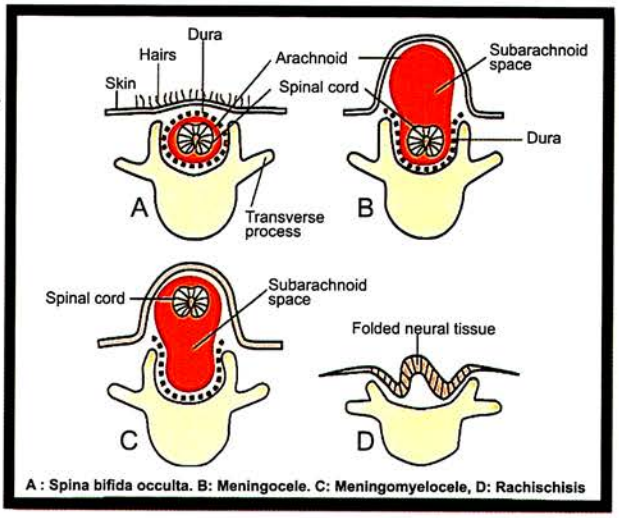
Spina Bifida

Spina bifida oculta-> Most common ,called occulta bcz this is hidden, hair is seen in lumbosacral region,though the spine is bifid, but spinal cord and meninges are inside the region of vertebrae itself as shown.

Meningocele : Meninges has been moved out and produce cyst in the lumbo sacral region, on aspiration we get csf.

Meningomyelocele When neural tissue also come inside Meningocele. When spinal cord has moved into cyst, in lumbo sacral region.

Rachischias is Least common,non closure of posterior neuropore, we can see spina bifida and the neural tube is open, spinal cord is open, csf is leaking out, survival is rare-they die prematurely



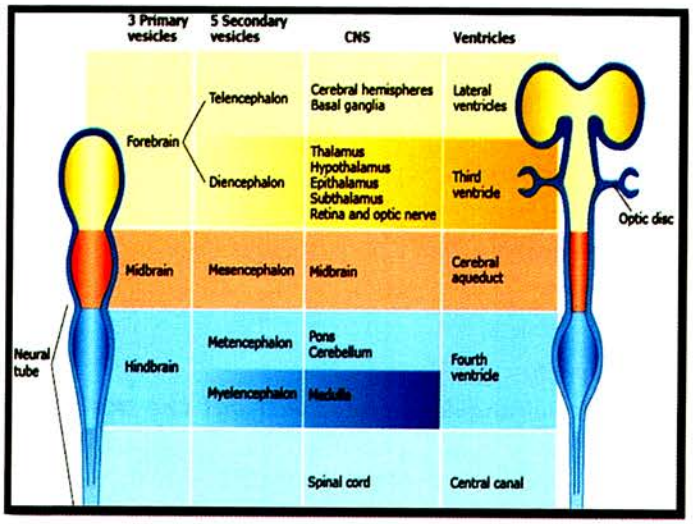
A : Spina bifida occulta. B: Meningocele. C: Meningomyelocele, D: Rachischisis

Lumbosacral cyst

On aspiration CSF positive ,Neural tube present a/k **Spina bifida cystic with meningomyelocele.**

Key note- if clear cyst: Meningocele, If Non clear cyst: Neural tissue positive.

Development of Ventricles:

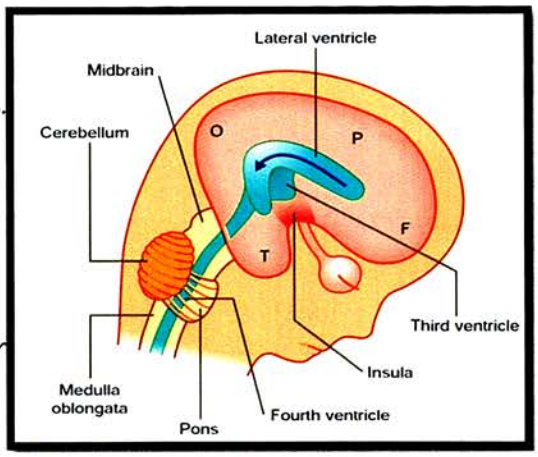


Development of Ventricles:

Key notes-

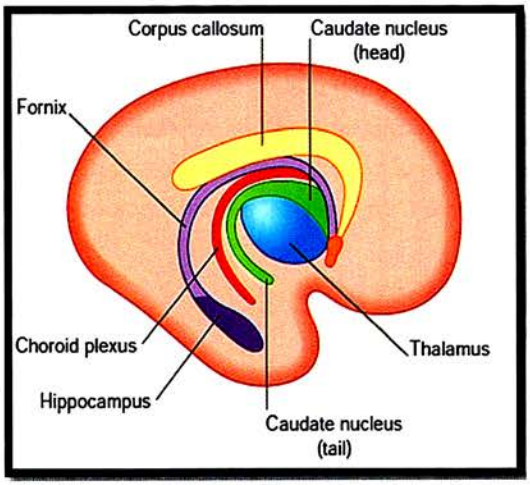
1. **Telencephlon** –part of it will grow inside nose and become **olfactory nerve.**
2. **Diencephlon** go inside to the eye become **Retina and optic nerve "They are not true nerves,they are central nervous system invagination, Prolongation and myelinated by oligodendrocytes (not myelinated by Schwann cell)"**
3. Brain stem include Mid brain ,pons and medulla oblongata"
4. At Ponto-medullary junction Cranial nerve No 8 **(Vestibulo-cochlear)** comes out
5. **Optic nerve, Vestibulo-cochlear nerve ,olfactory nerve** are the **pure sensory nerve.**

As the brain is developing there is limited space to grow Hence it bends and become spherical, Cerebrum and lateral ventricles becomes **C shaped** (also basal ganglia, caudate nucleus). Lateral ventricles develop some horns : **Ant frontal horn, posterior occipital horn and the inferior temporal horn.** Most of the CSF is formed by **Choroid plexus** in lateral ventricle and Then move into **mid-line ventricle(3RD Ventricle)** pours CSF via **Cerebral aqueduct of sylvius into 4TH ventricle.** About 4TH Ventricle→ Cerebellum post as Roof, Pons Ant as Floor From 4 th Ventricle CSF moves **into Central canal** inside **Spinal cord.**



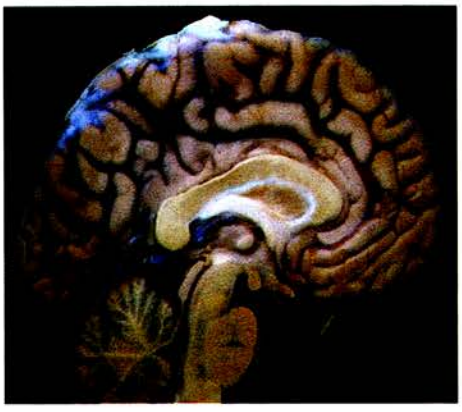
C-shaped Structure-

Cerebrum, Carpous-callosum, fornix, Choroid plexus, Caudate nucleus of basal ganglia. Thalamus is the axis. **Ant commisure**is the **first commisure** connect the right part of the Brain to left part of brain. e.g olfactory bulb of one side Connect to other side connected via ant commisure.**2nd commisure to develop is the Fornix ,** fornical commisure connect one Hippocampal area with other. Choroid plexus goes to roof of 3rd ventricle and also comes towards 4th Ventricle.

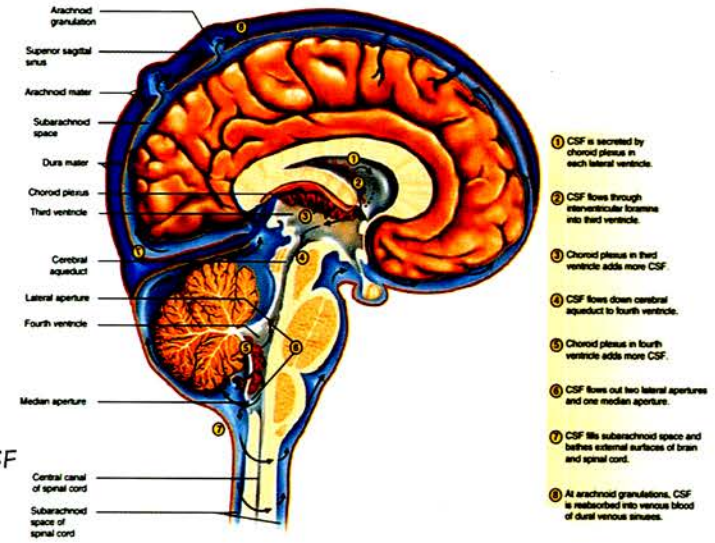


Saggital section of Brain

Largest ventricle are the lateral ventricle(Within the cerebrum), CSF produced escapes through Lateral ventricle via **Foramen Of Monro** → CSF will Enter **Hypothalamic sulcus → 3rd ventricle → Aqeduct of Sylvius4th → Ventricle → central canal**



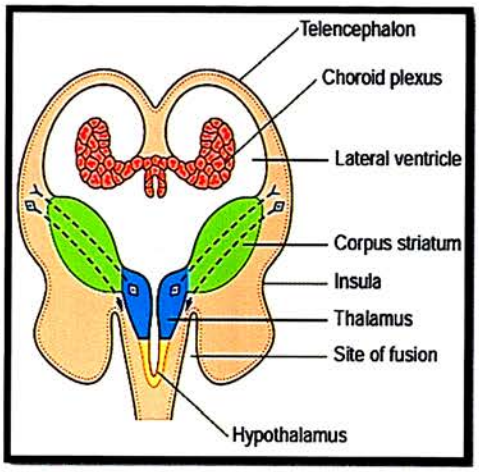
Some of Csf **escapes 4TH ventricle**. At the **roof of 4TH Ventricle**, there is opening called **foramen of magendie(Midline foramen)** and two **lateral foramen called foramen of luschka**, to enter the **subarachnoid space**→ absorbed by **arachnoid granulation**-dural venous sinuses (Superior Saggital sinuses) → **Internal Juglar Vein**→ **Heart**→ towards lung for oxygenation. Oxygenated blood comes to brain through the carotid system and vertebral artery system and then form choroid plexus (capillary plexus forming ultrafiltration→ CSF



Developing Brain-Front View/Coronal section

Choroid plexus or capillary plexus projecting into lateral ventricle to form CSF, also projecting at the roof of the 3rd Ventricle.
3rd ventricle is the midline ventricle **sandwiched between thalamus.** (Superior thalamus and inferior hypothalamus),Hypothalamus is not only the lateral Wall of the third ventricle but **also the floor of the third ventricle.**
Axons are projecting from higher brain center to lower brain center & Vice-versa they will become the **projection fibers, internal caspsule** & **divide in corpus striatum** part of basal ganglia into two parts.
Corpus striatum divide into two parts—

a. Lateral to internal capsule : Lentiform nucleus
b. Medial to internal capsule : Caudate Nucleus



Third Ventricle

BOUNDARIES

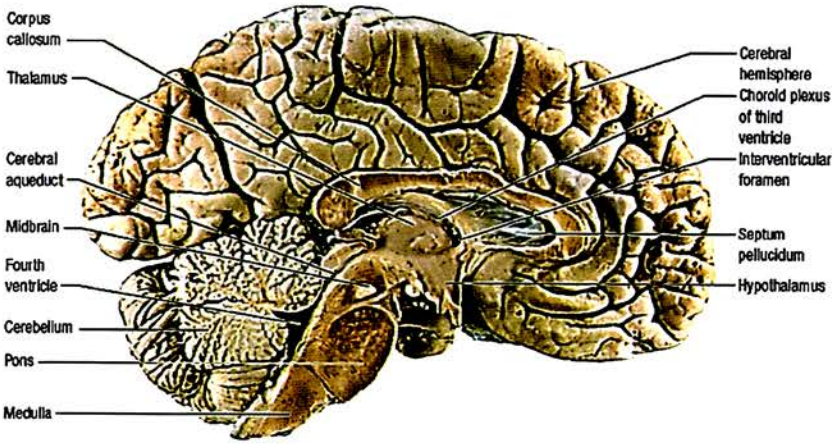
EXTENT → Starts from foramen of monro to beginning of aqueduct of sylvius

Lateral Wall

→ Thalamus (above)
Hypothalamus (below)

Floor

→ Mammillary body of hypothalamus
→ **Tegmentum part of midbrain**
→Tuber cinereum of hypothalamus



→ **Infundibular stalk**

Downward extension of diencephalon

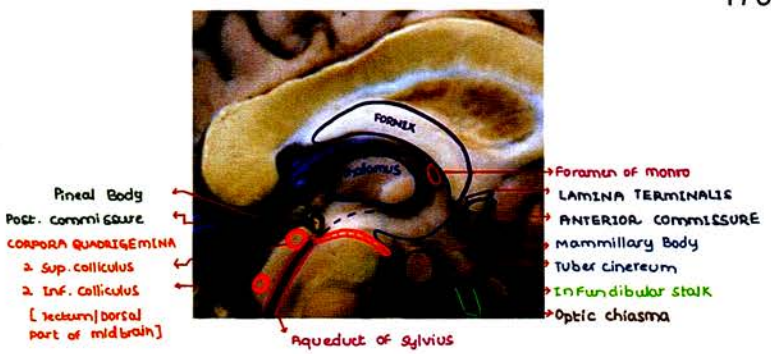
Connects neurohypophysis / posterior pituitary

→ **Optic Chiasma**

- Most anterior structure

ROOF

→ **Fornix**



Anterior

Fornix (some part)

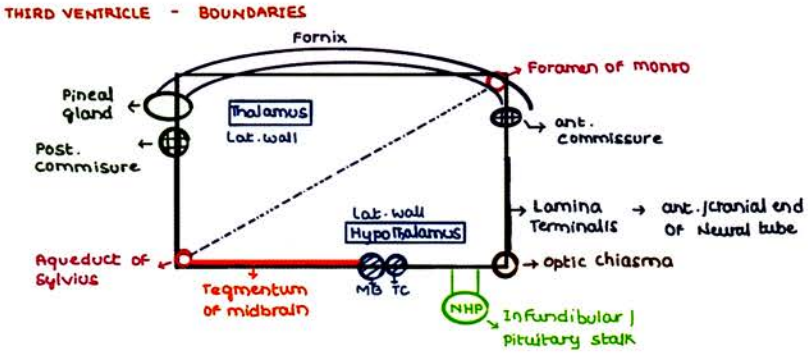
Lamina Terminalis

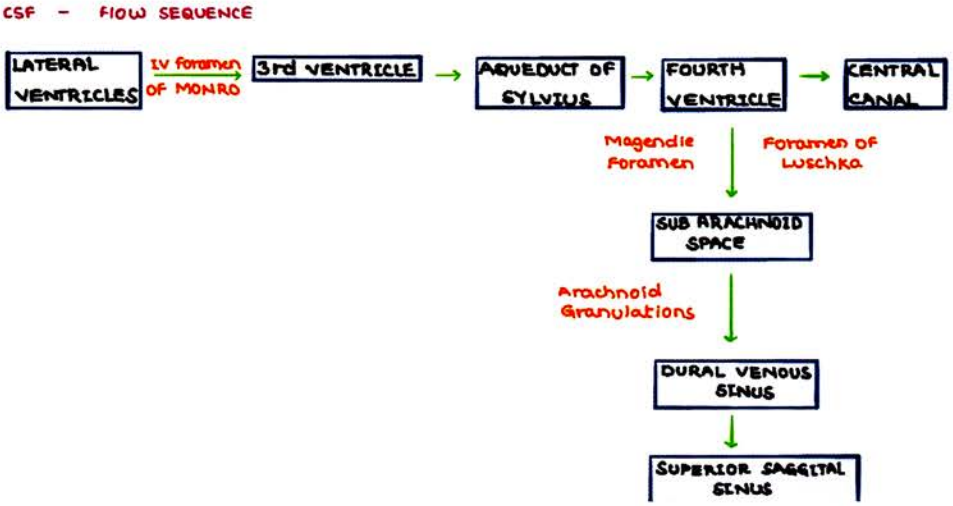
Anterior commissure

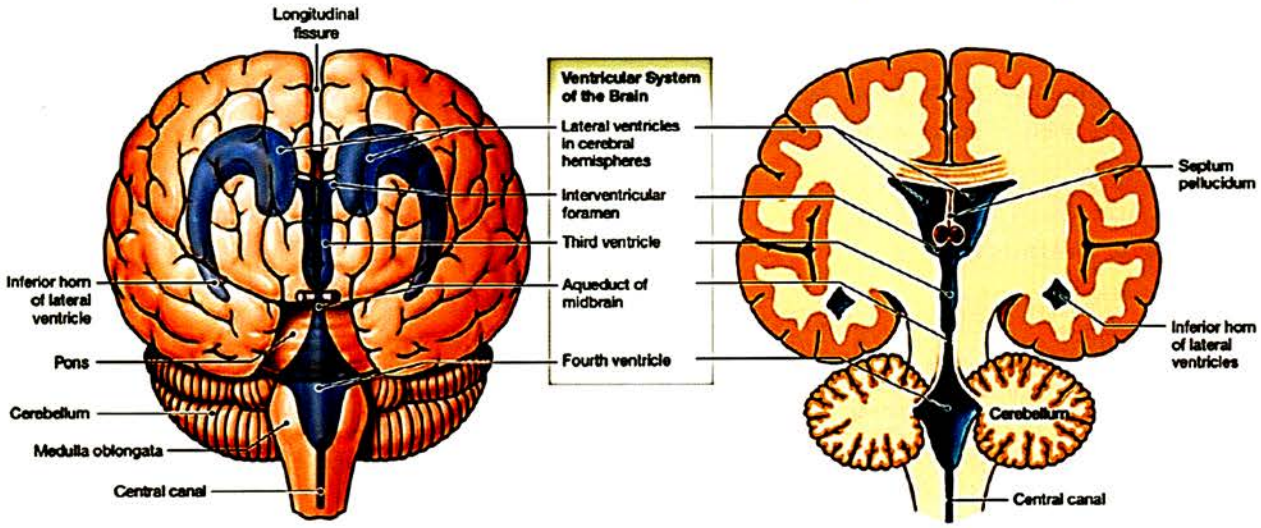
Posterior

Pineal Body

Posterior commissure

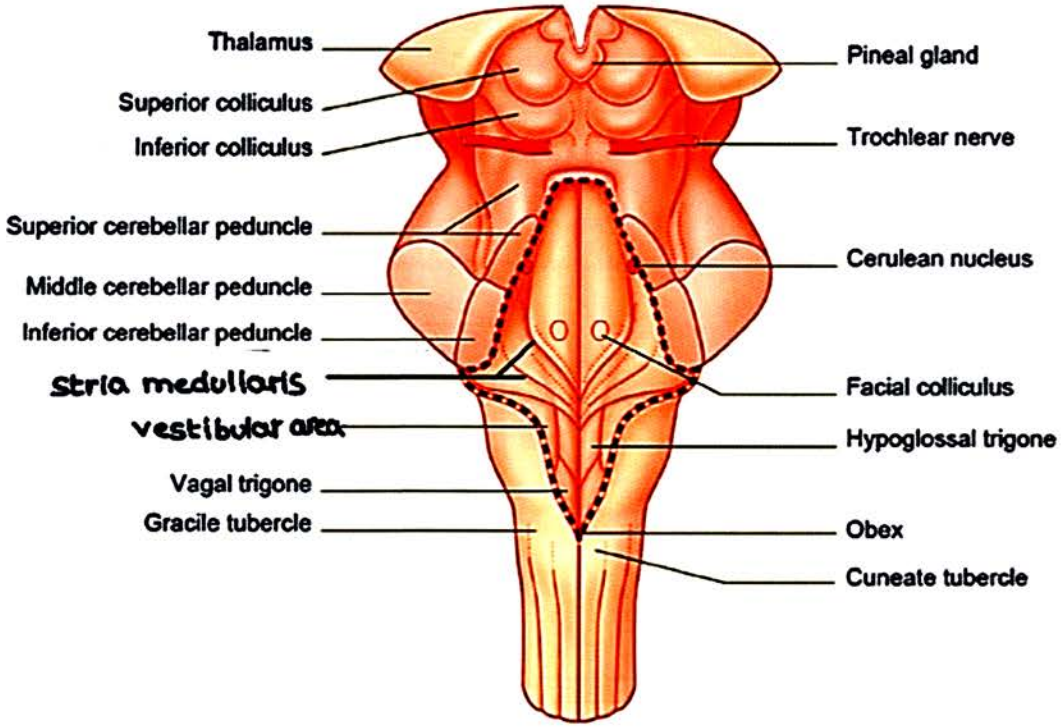






Fourth Ventricle

Floor→ Pons and upper half of M. oblongata



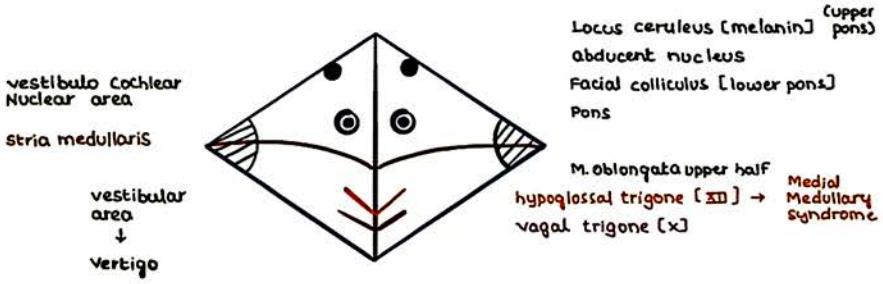
Contents of 4th Ventricle

1. **Facial colliculus** → rounded elevations by axons of **facial nerve** [deep to this, **abducens** nucleus that, but abducens nucleus do not produce elevation]
   → present in **dorsum of lower pons**
2. **Stria medullaris** → Striations moving towards medulla
3. **Hypoglossal Trigone**
   → most medial nucleus
   → Hypoglossal nucleus
   → Elevation of hypoglossal nucleus (XII)
   → Hypoglossal Trigone
4. **Vagal Trigone**
   → Lateral to hypoglossal trigone
   → due to elevation of **vagal nerve nucleus (X)**
5. **Vestibular area**
   → most lateral
   → **VIII nerve presents here**
   → Hypoglossal Trigone
   Vagal trigone
   present in **upper half** of Vestibular area M. oblongata

→ On medial **medullary syndrome** → **hypoglossal nucleus** is involved tongue muscle palsy
→ **Tongue muscle palsy**

→ In **lateral medullary syndrome** → vestibular nucleus is involved
→ **Wallenberg syndrome** with vertigo

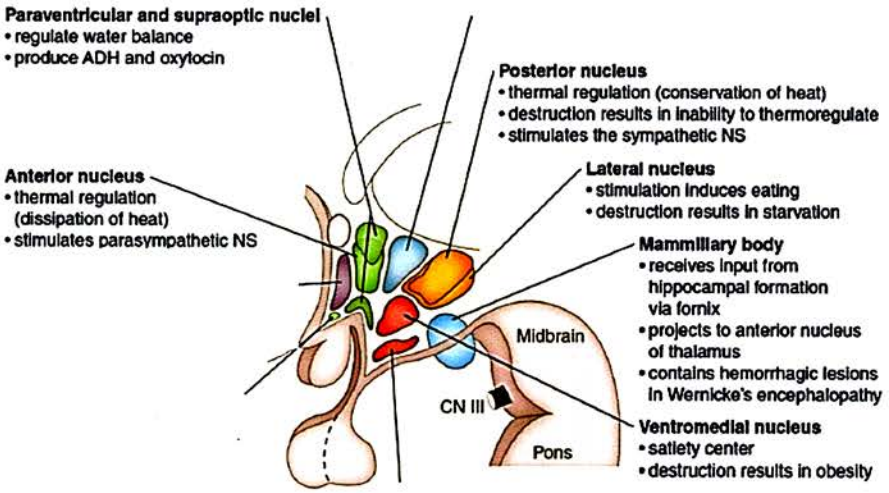
6. Nucleus ceruleus
   → dark colored d/t melanin deposition
   →



Hypothalamus

VMS [ventro medial satiety] centre
- → satiety centre
- → destruction → obesity

Mammillary body
- → present in floor of 3rd ventrcel
- → part of PAPEZ circuit
- → receives input from hippocampus Via fornix
- → projects to ant. nucleus of Thalamus
- → Contains haemorrhagic lesions in Wernicke's encephalopathies

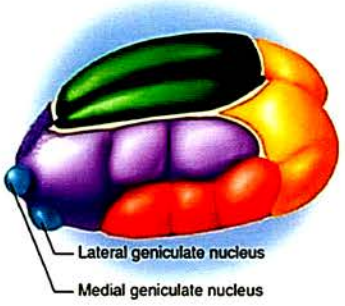


Anterior nucleus
- → Thermal regulation [Dissipation of heat]
- → Stimulation of **parasympathetic system**
- → **Vasodilation** in periphery

Posterior nucleus
- → **Thermal** regulation [conservation of heat]
- → Stimulation **of sympathetic** nervous system
- → **Vasoconstriction in periphery**

Para ventricular & supraoptic nuclei
- → Regulates **water balance**
- → Produce **ADH & oxytocin**

Thalamus → Relay centre



(a) Thalamus

Thalamic nuclei	
Anterior group	Part of limbic system; memory and emotion
Medial group	Emotional output to prefrontal cortex; awareness of emotions
Ventral group	Somatosensory output to postcentral gyrus; signals from cerebellum and basal nuclei to motor areas of cortex
Lateral group	Somatosensory output to association areas of cortex; contributes to emotional function of limbic system
Posterior group	Relay of visual signals to occipital lobe (via lateral geniculate nucleus) and auditory signals to temporal lobe (via medial geniculate nucleus)

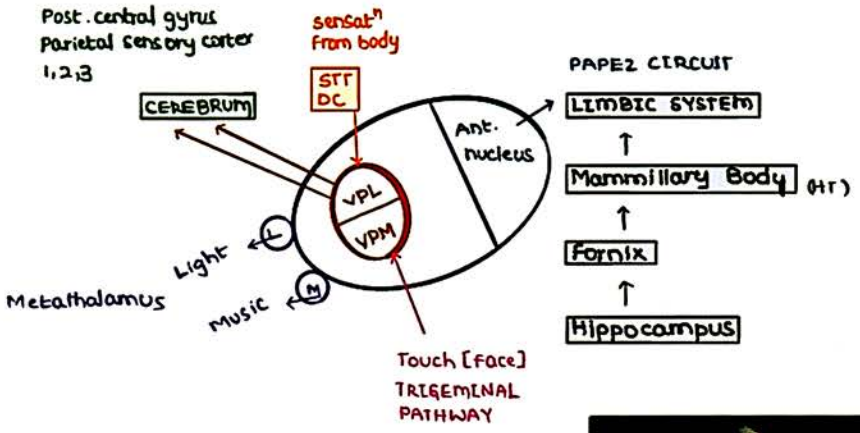
Ventral Group

Ventro postero **lateral** [VPL] Nucleus → For **body** region

Ventro Postero **medial** [VPM] Nucleus → For **head** region

VPM nucleus

→ Receives spino thalamic tract & **dorsal column** [brings **touch sensation** from upper limb and lower limb] & projects to **post central gyrus.**



Cerebral Homunculus

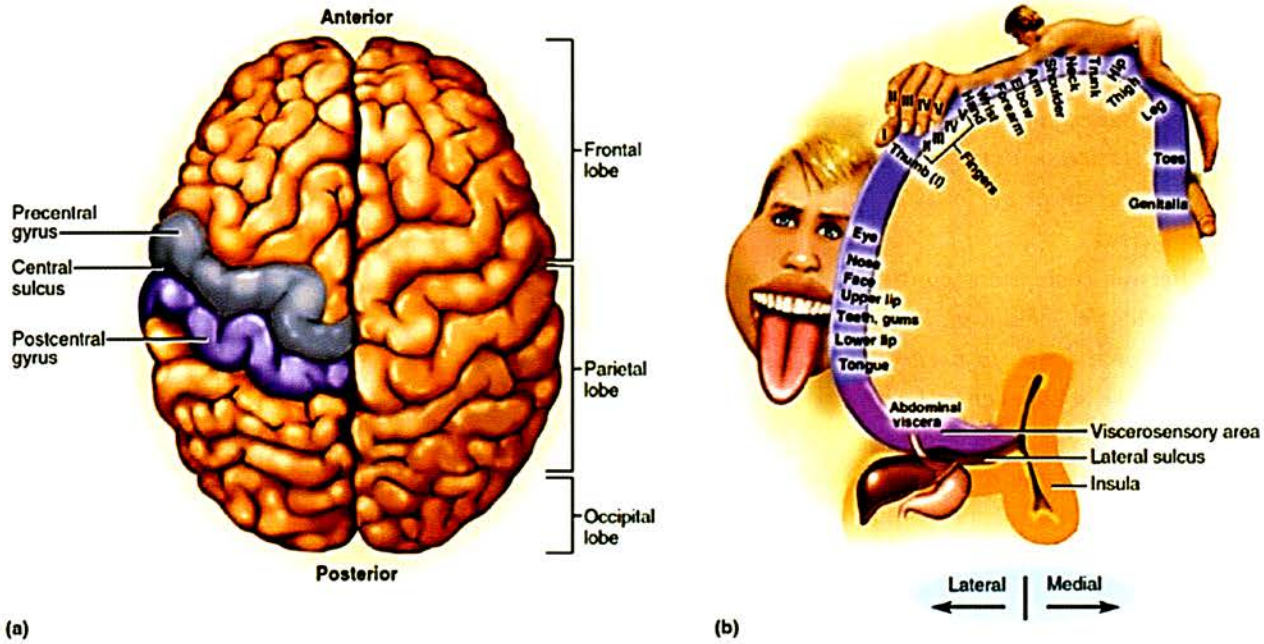
Homunculus → Representation of body on cerebrum

→ upside down

→ **In a oblique fashion** [along the central sulcus]

→ Both **motor & sensory**

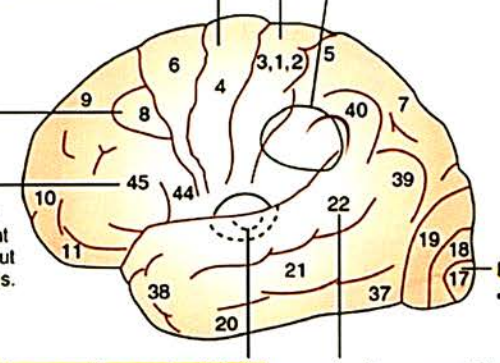
→ **Hand & face has more representation**



Lower & lateral	→ face area
Higher	→ upper limb area
Still higher	→ pelvis perineum area
On medial surface	→ lower limb area, part of pelvis & perineum

Cerebrum: Brodmann numbers

A. Lateral view



Primary somatosensory cortex (3, 1, 2)
- Lesion causes contralateral loss of touch, vibration, and stereognosis in affected area.

Lesion of right parietal lobe results in left-sided neglect. Patient fails to recognize that the left side of his/her body exists.

Primary motor cortex (4)
- Lesion causes contralateral hemiparesis in affected area.

Frontal eye field (8)
- Lesion in left hemisphere causes eyes to look left. Lesion of right hemisphere causes eyes to look right.

Broca's speech area of left hemisphere (44, 45)
- Destruction causes Broca's (expressive) aphasia. Patient understands spoken word but cannot form fluent sentences.

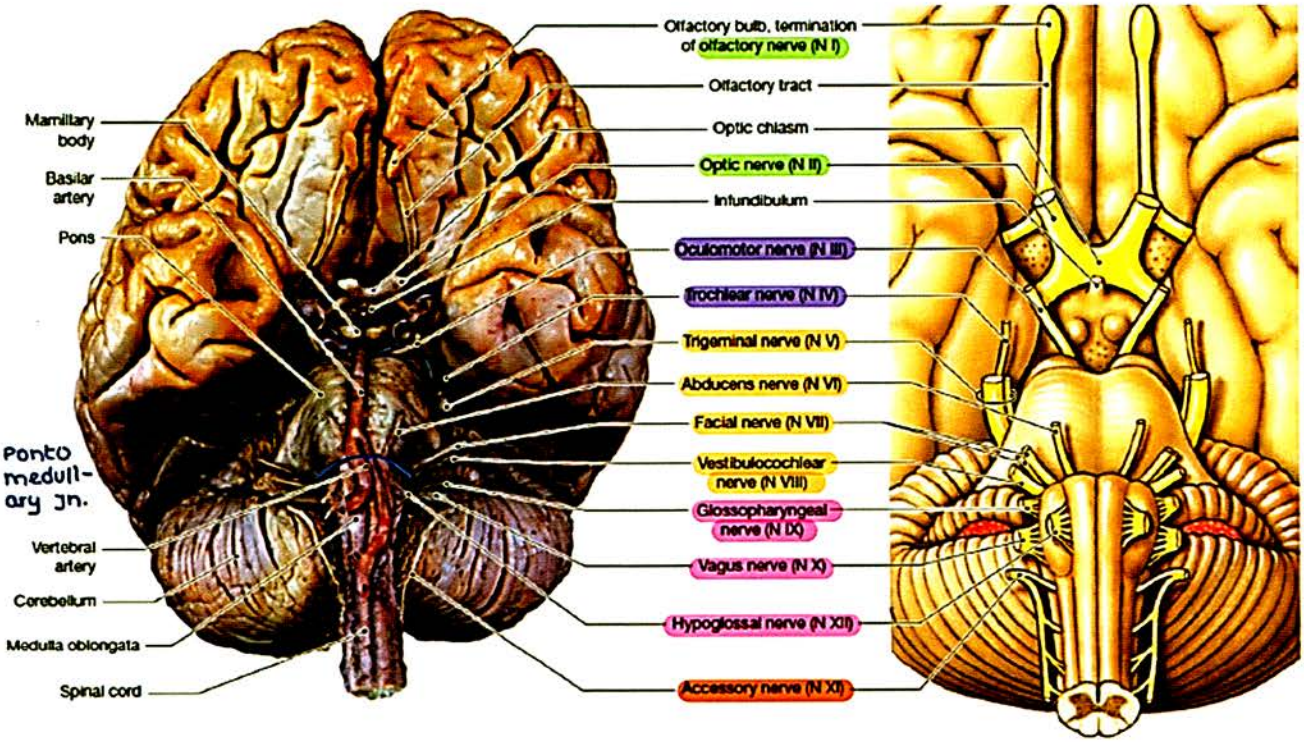
Primary visual cortex (17)
- Lesion causes visual field deficits.

Primary auditory cortex (41, 42)
Superior temporal gyrus

Auditory association cortex (Wernicke's speech area of left hemisphere) (22)
- Destruction causes Wernicke's aphasia. Patient cannot understand spoken word, and speech is fluid but does not make sense.

Cranial Nerves

→ 12 pairs
→ 1, 2 → come from for brain
→ 3-12 → come from brain stem
→ Mid Brain
→ Pons
→ Medulla



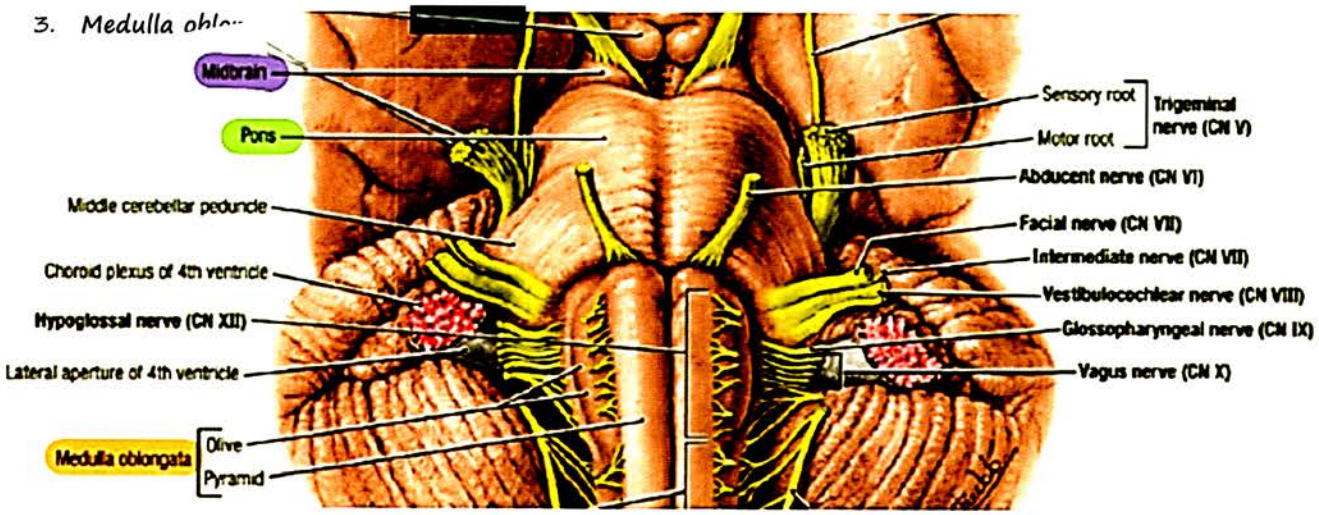
INFERIOR VIEW [BASE]

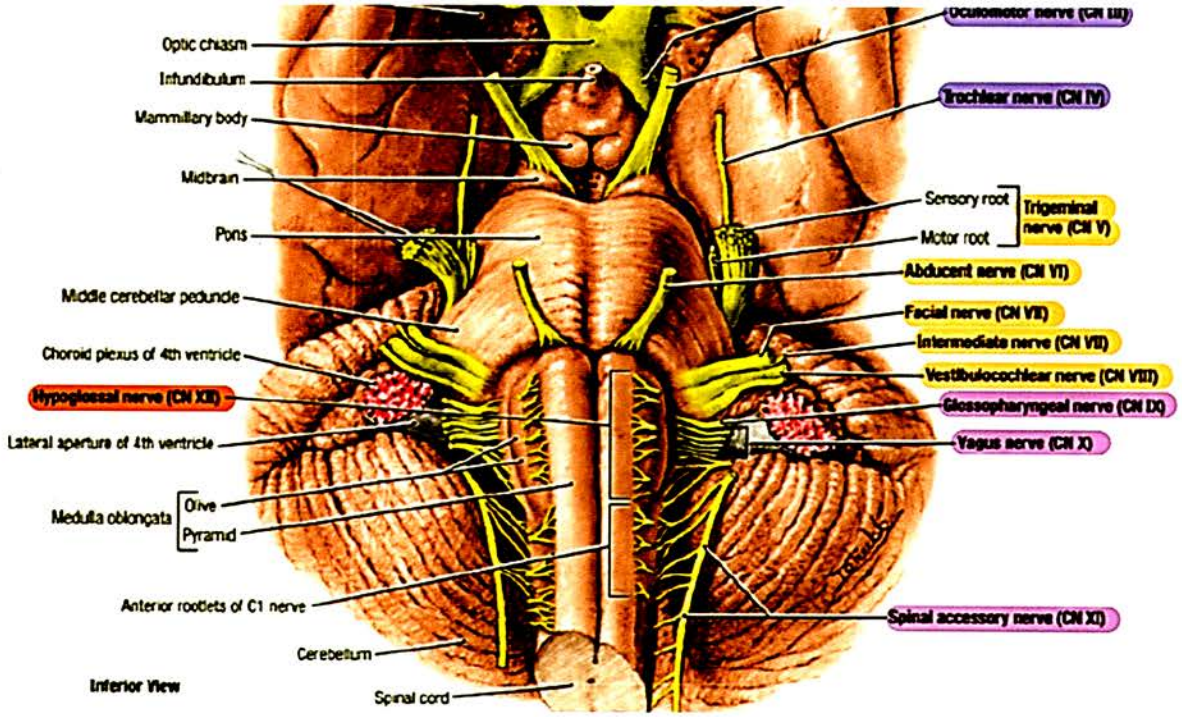
Thickest → TRIGEMINAL NERVE (V)

CN I, II → Comes from Fore Brain
CN III, IV → Comes from Mid Brain
CN V → Comes from Pons
CN VI, CN VII, CN VIII → Comes from Ponto medullary junction
CN IX, CN X, CN XI → Comes from Medulla Oblongata behind olive
CN XII → Comes from Medulla Oblongata infront of olive

Brain Stem

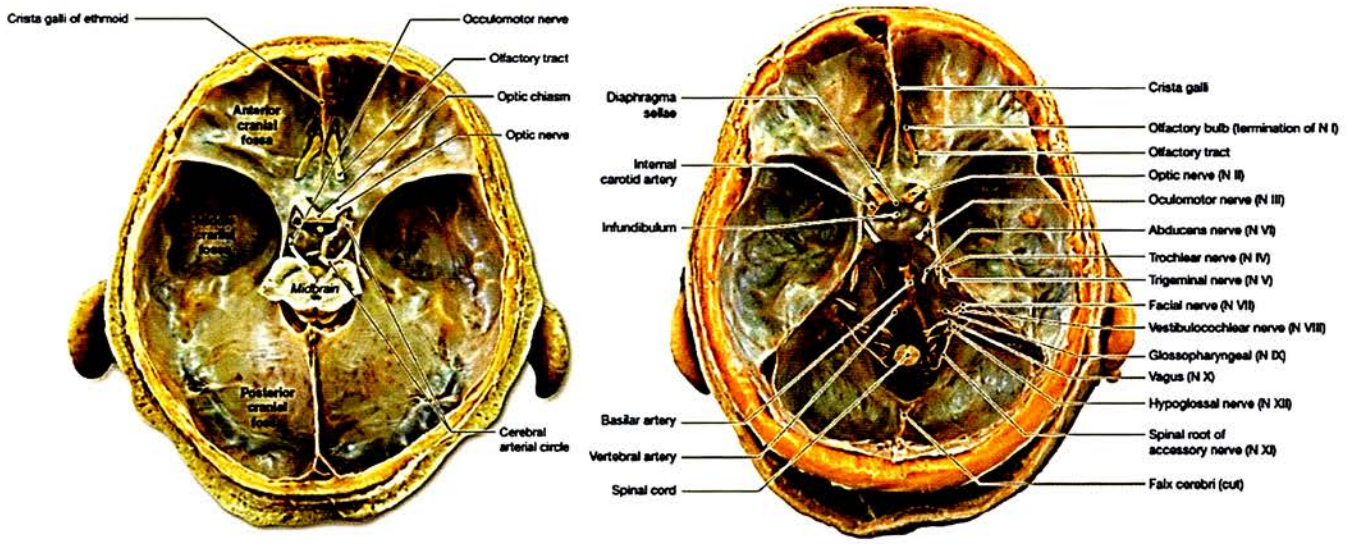
1. Mid Brain (crus cerebri)
2. Pons
3. Medulla oblo...





CRANIAL NERVES		LOCATION
OCCULOMOTOR NERVE [III]		MID BRAIN
TROCHLEAR NERVE [IV]		MID BRAIN
TRIGEMINAL NERVE [V]		PONS
ABDUCENT NERVE [VI] (near midline)		PONTO MEDULLARY JUNCTION
FACIAL NERVE [VII] [Lateral to CN VI)		PONTO MEDULLARY JUNCTION
VESTIBULO COCHLEAR NERVE [VIII] [lat. to CN VII] – has 2 components		PONTO MEDULLARY JUNCTION
GLASSOPHARYNGEAL NERVE [IX] VAGAL NERVE [X] CRANIAL ACCESSORY NERVE [XI]	present behind olive	MEDULLA OBLONGATA NUCLEUS AMBIGUS
HYPOGLOSSAL NERVE [XII]	→ present blw pyramid & olive	MEDULLA OBLONGATA

Cranial nerves & Related Skull Foramina

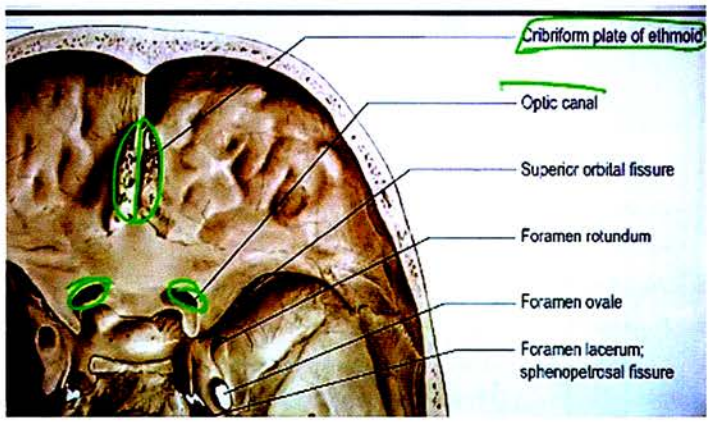


Anterior cranial Fossa Foramina of skull

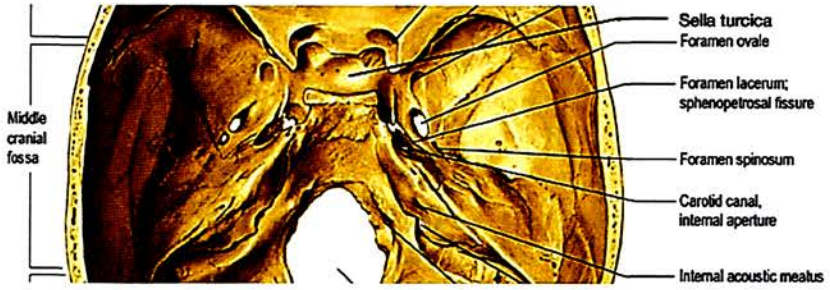
1. Olfactory nerve → cribriform plate of ethmoid
2. Optic nerve → Optic canal

In midline tumor of pituitary gland → **Optic chiasma** affected

→ Bitemporal hemianopia
- Peripheral vision is lost
- Tunnel vision present



Floor of middle cranial fossa



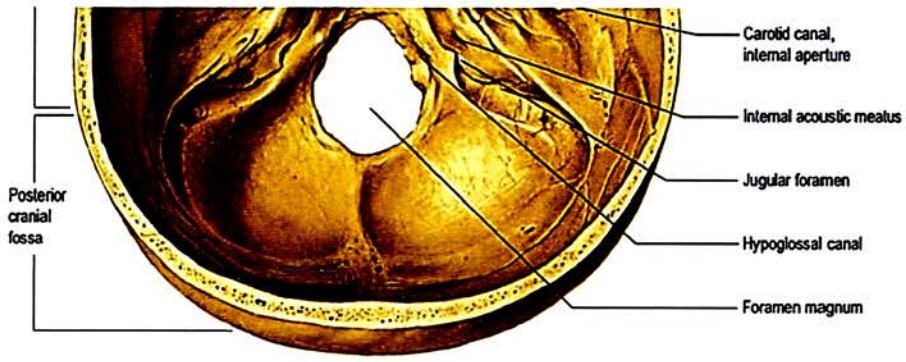
1. **Greater Wing of Sphenoid Openings**
   - i. Foramen Rotuandum
   - ii. Foramen ovale
   - iii. Foramen spinosum
2. **Superior orbital fissure**
   → Gap b/w lesser wing & greater wing
3. **Body of Sphenoid**
   → present in
   Anterior cranial fossa
   Middle cranial fossa
   Posterior cranial fossa
   → **Sella Tursica → Body of sphenoid in floor of MCF to keep pituitary gland**

Cavernous sinus contents

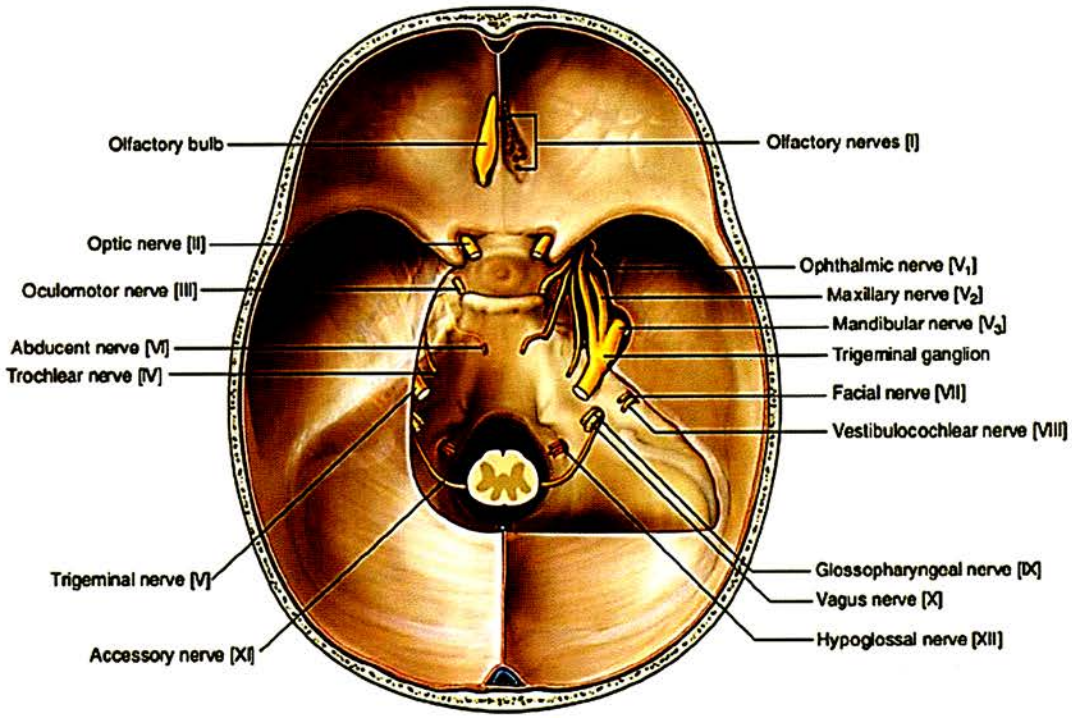
1. **Internal carotid artery**
2. **Occulomotor nerve (3) → most medial**
3. **Abducent nerve (4)** → **Puncture dura matter** at floor of post. cranial fossa & becomes intradural has longest intra dural course] & enter cavernous sinus
4. **Trochlear nerve (s)** → **most lateral**
   → **thinnest cranial nerve**
5. **Ophthalmic Division of trigeminal nerve**
   → gives 3 sensory branches & passes through superior orbital fissure
6. **Maxillary division of Trigeminal Nerve**
   → passes through foramen rotundum & supply maxilla

CN 3,4,5 passes through superior orbital fissure & supply eye ball

Floor of posterior cranial fossa



1. **Internal auditory meatus**
   - In petrous temporal bone
   - Facial nerve enter through it
2. **Jugular foramen** → present below IAM
3. **Hypoglossal canal** → for CNXII
4. **Foramen magnum** → **present in occipital bone**



Nerves and Foramen

Trigeminal nerve

→ forming ganglia at middle cranial fossa floor

→ **largest cranial nerve**

→ 5_1 → ophthalmic nerve

5_2 → maxillary nerve

5_3 → mandibular nerve (**passes foramen ovale & supply mandible**)

Posterior Cranial fossa	Foramen of skull
1. CN 7	Internal auditory meatus
CN 8	
2. CN 9	Jugular foramen
CN 10	
CN 11	

Spinal accessory nerve

→ **Enter** the cranial cavity **through foramen magnum exit** the cranial cavity through **jugular foramen**

→ **have short intra cranial course**

3. CN 12 → **Hypoglossal canal**

Substantia Nigra

→ present in **mid brain** in posterior cranial fossa

→ occulomotor nerve comes anterior to it **at the level of superior colliculus** Foramen magnum contains lower part of M. Oblongata

Spinal cord → **present below foramen magnum**

Trochlear nerve

→ only cranial nerve with dorsal in brain

→ comes from mid brain

→ present at level of inferior colliculus

Corpora Quadrigemina

1. Superior colliculi
2. Inferior colliculi

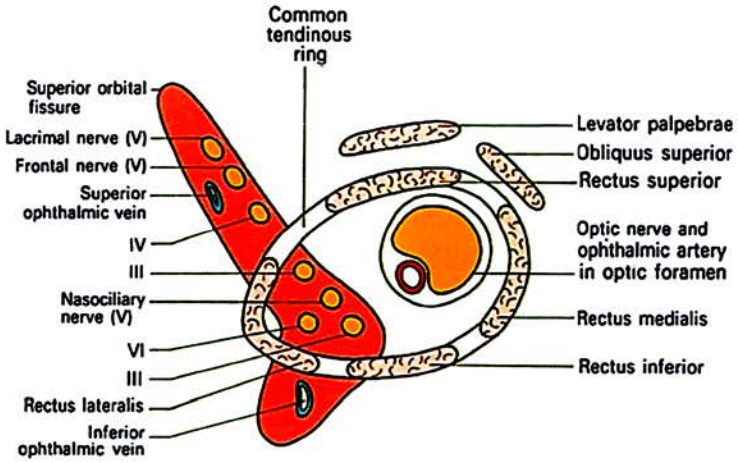
Superior orbital Fissure

Nerves Left outside the ring of ZINN

L → Lacrimal nerve

F → Frontal nerve

T → Trochlear nerve



Veins left outside the ring of ZINN

Superior ophthalmic vein

Inferior ophthalmic vein

Nerves passing inside the ring of ZINN

CN 3 [superior division (supplie superior Rectus & inferior division (supplies Inferior, rectus)]

CN 6

Nasociliary nerve

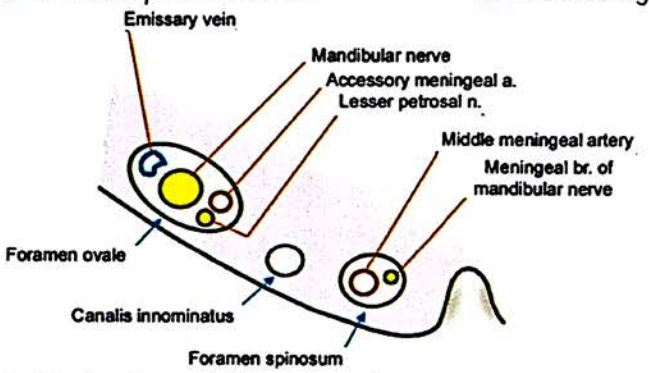
Structure passing through **foramen ovale** (MALE)

M → **mandibular nerve**

L → **Lesser petrosal nerve**

A → **accessory meningeal artery**

E → **Emissary vein**



→ In some Lesser petrosal nerve found in canalis innominatus

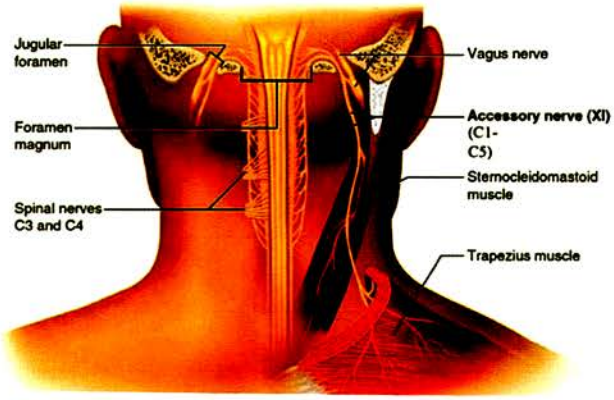
Structure passing through foramen spinosum:

1. Middle meningeal artery
2. Nervous spinous (**branch Of mandibular nerve**) → supplies dura-matter, on floor of MCF.

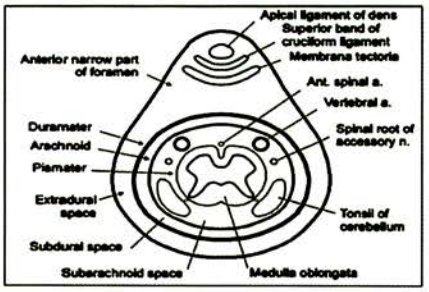
Foramen magnum contents

Medulla oblongata
SAN on each side
Vertebral arteries on each side
} present under arachnoid meatus surrounded by CSF

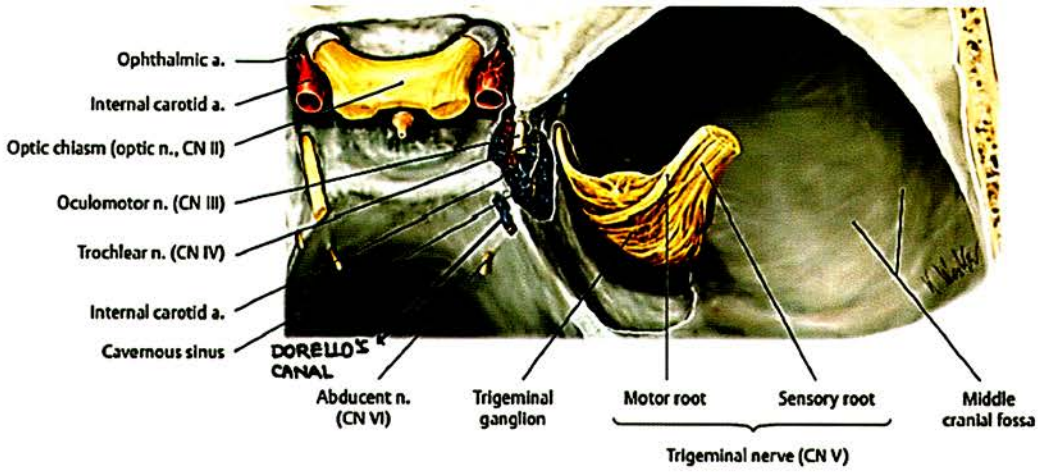
Tectorial membrane → continuation of posterior longitudinal ligaments & enters foramen magnum & attaches to occipital bone.



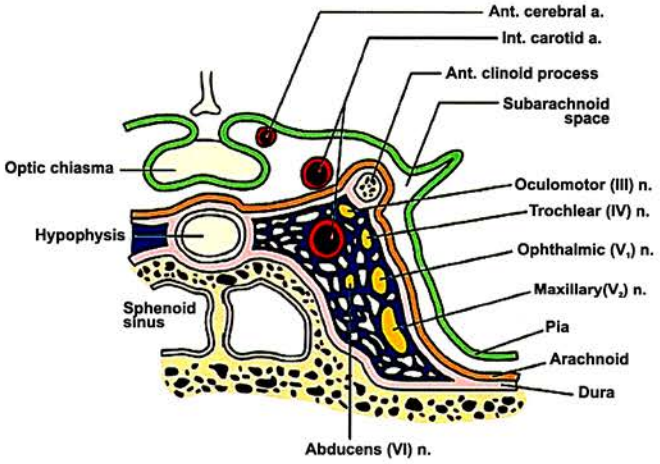
Structures passing through foramen magnum



Cavernous Sinus



Abducens nerve enters CS through DORELLO'S CANAL

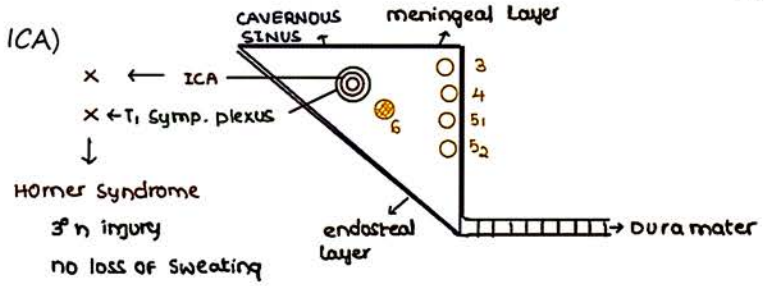


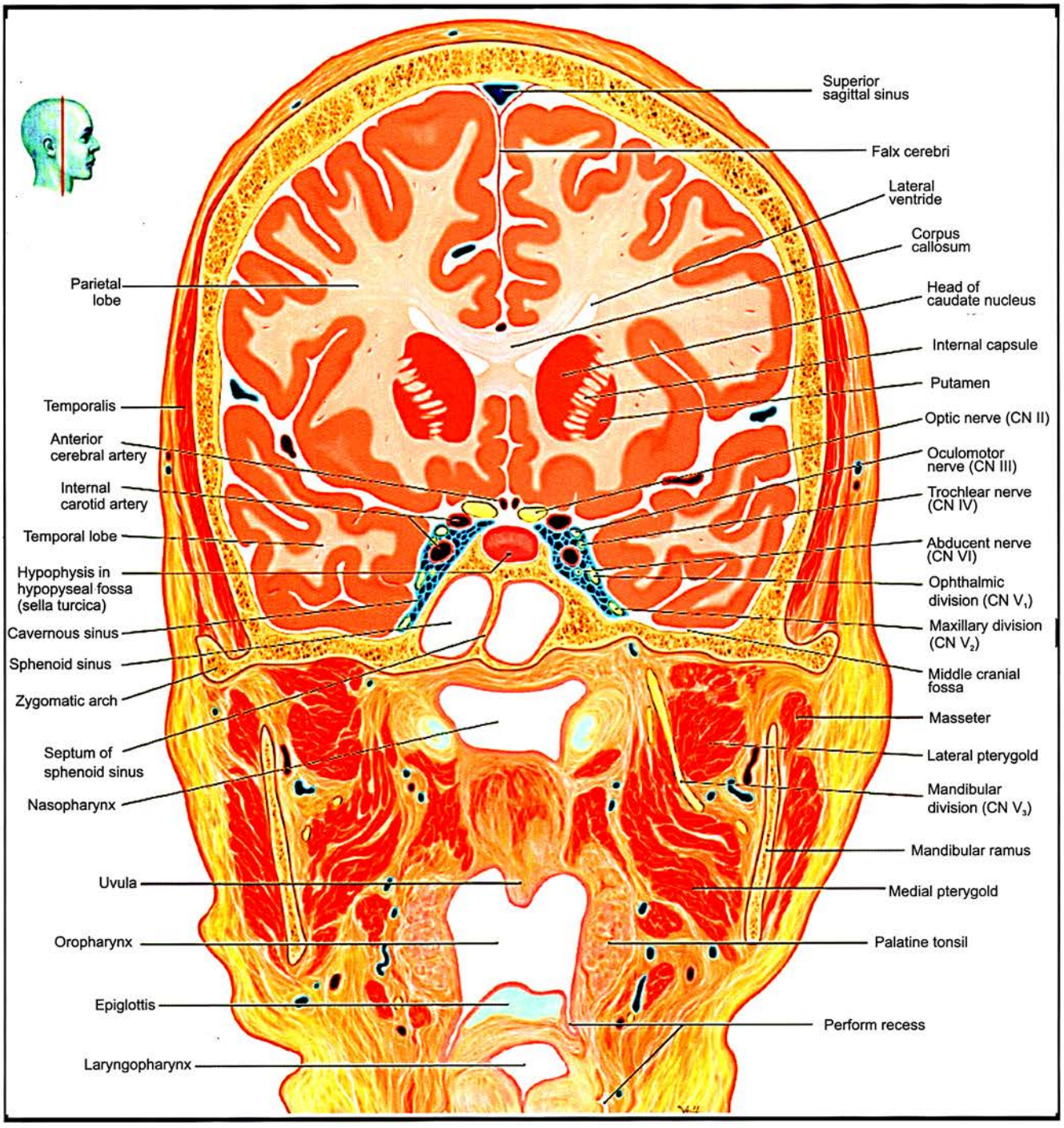
Contents

1. Internal carotid artery (Direct content)
2. T1 sympathetic plexus (surrounds ICA)
3. Abducens nerve → Direct content
4. Occulomotor
5. Trochlear
6. **Ophthalmic (V1) nerve**
7. **Maxillary (V2) nerve**

→ Intra dural sinus [**b/w endosteal & meningeal layer of dura mater**]

→ Abducens nerve has **longest intradural course** & infero lateral **to ICA**

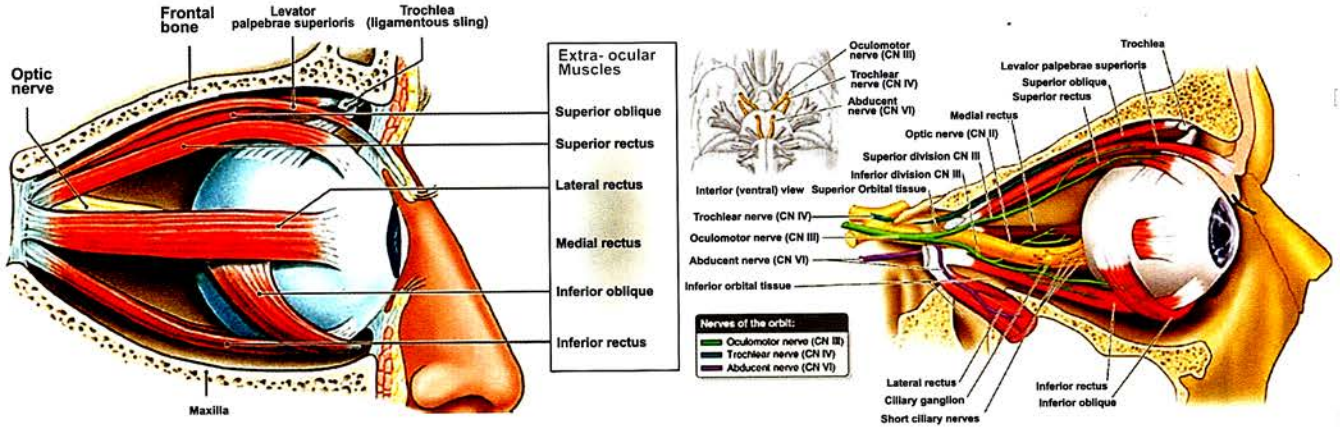




Cranial Nerves: 3,4,6

→ Common Tendinous **ring of Zinn** → common **origin of all 4 recti**

→ Inferior oblique muscle passes under **Inferior Rectus & deep to lateral rectus & inserts on sclera.**



→ CN 3, 4 → comes from **mid brain**

→ CN 6 → comes from **ponto medullary junction near the midline**

Trochlear nerve → supply superior oblique muscle

Abducent nerve → supply lateral rectus

Occulomotor nerve

Superior division → supply superior rectus

Inferior division → supply inferior rectus

Trochlear nerve passes outside the ring of zinn

CN 3,6 passes **inside the ring of zinn**

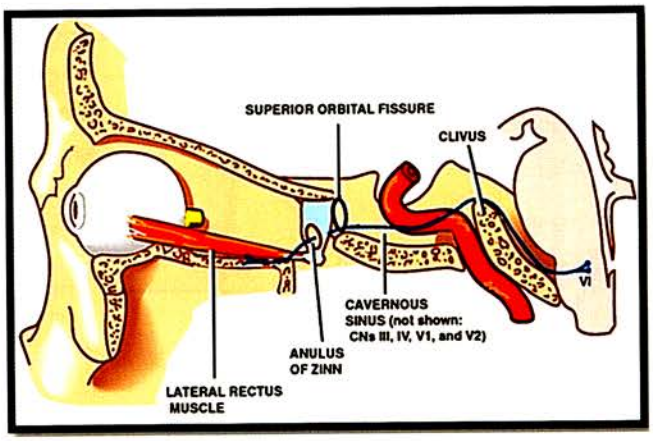
Abducent nerve (CNS)

Course

→ comes from **pons**

→ **Infero lateral to ICA** running through the cavernous sinus

→ Passes **inside the ring of zinn** through superior orbital fissure & supply the lateral rectus muscle



Right CNS Lesion

→ Rt lateral rectus paralysis

→ Medial rectus unopposed → medial squint

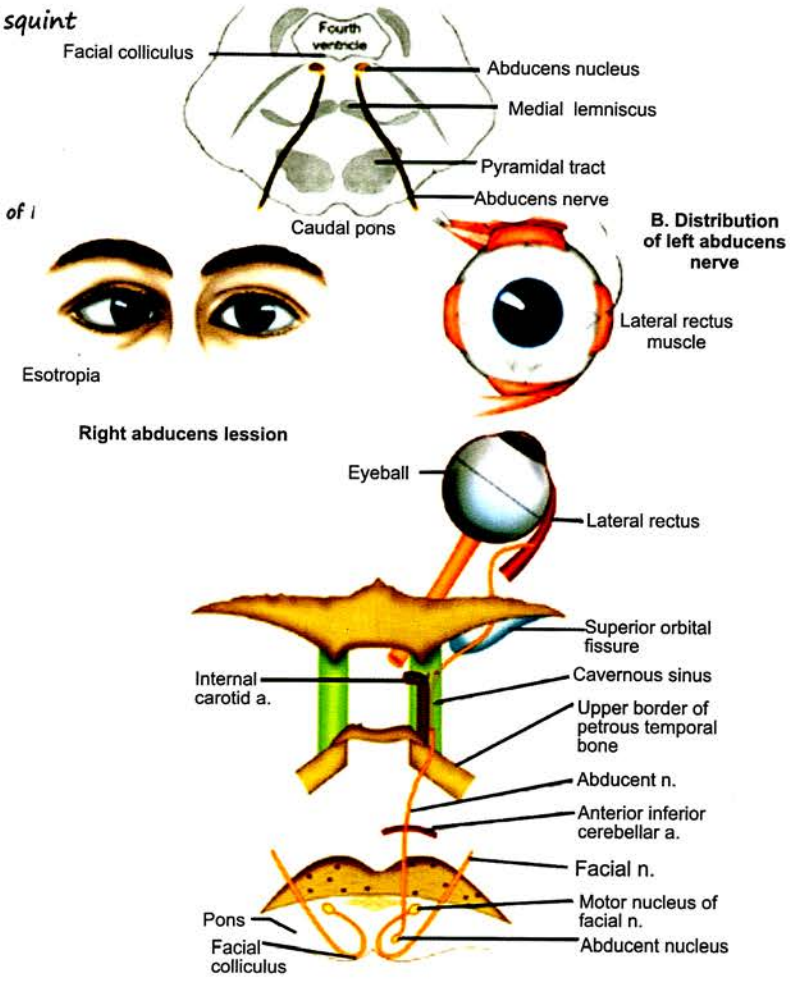
CN 4 Thinnest & smallest (size)

CN 5 Thickest & largest (size)

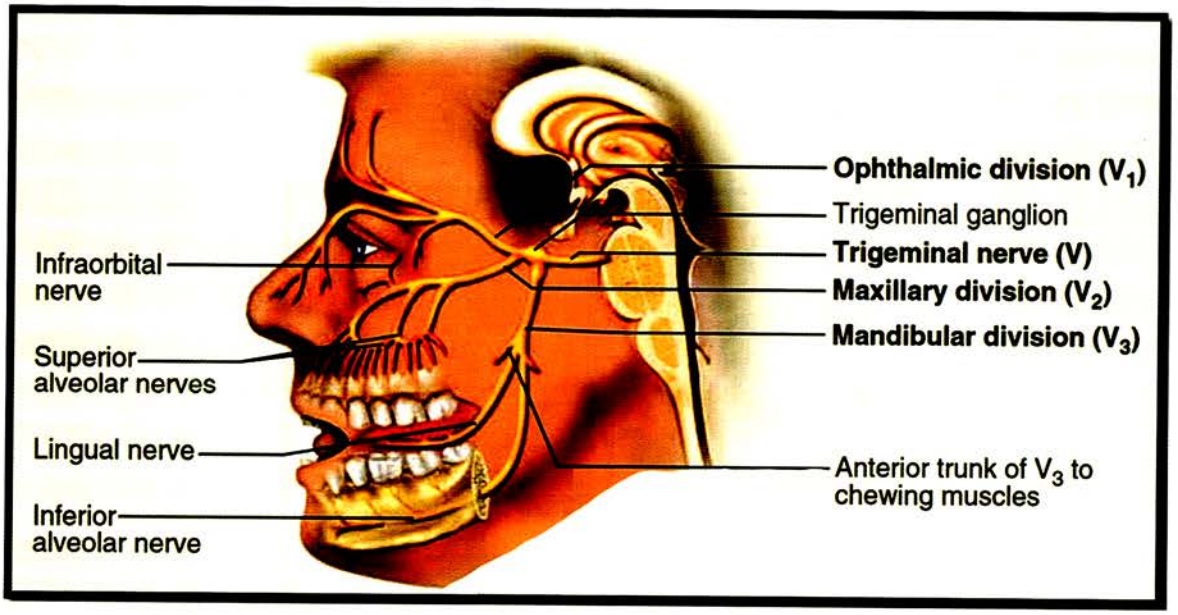
CN 1 Shortest (length)

CN 10 Longest (length) & largest distribution

CN 7 Longest intra osseous course (sup. & post. Wall of i



Trigeminal Nerve



Ophthalmic Branch (S_1)

→ supplies skin of fore head & tip of nose

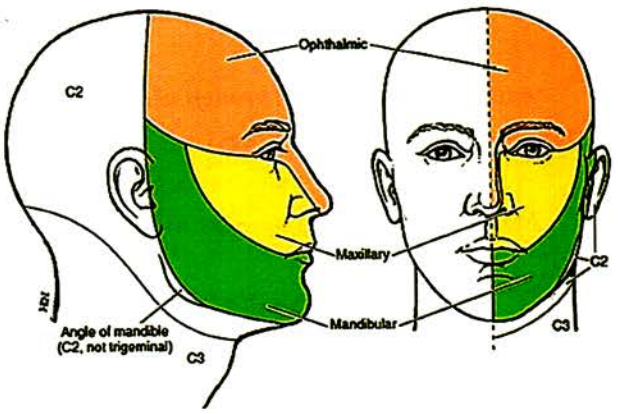
→ **In herpes zoster (vesicle at tip of nose)**

→ Ophthalmic branch is involved

Maxillary Branch (S_2)

→ Supplies Skin on lower eye lid, upper lip & maxilla bone

Mandibular Branch (S_3) → Supplies skin of mandible **except angle of mandible**



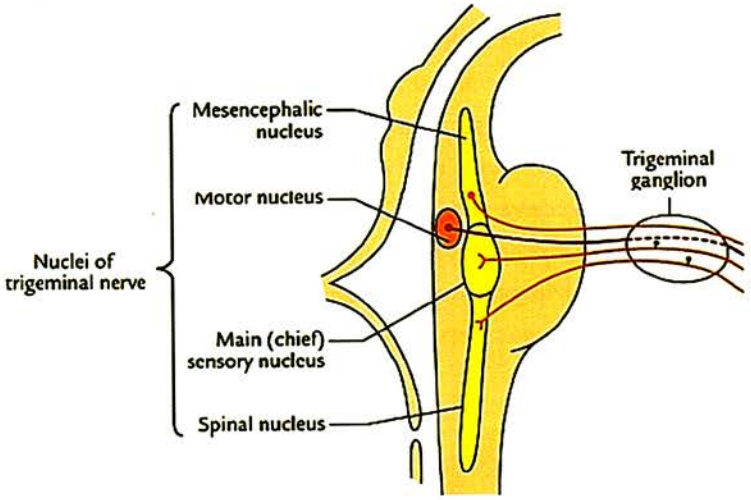
CN V (Trigeminal nerve) nuclei

→ 1 motor nucleus

3 sensory nuclei

→ **Motor nucleus present in Pons**

Controls muscles of 1st pharyngeal arch **(muscles of mastication)**



→ **3 sensory nuclei**

1. **Main sensory nucleus (pons)**

→ receives touch & vibration sensations

2. **Mesencephalic sensory nucleus (mid brain)**

→ receives proprioception (position sense) of aeye ball, mandible, tongue

3. **Spinal sensory nucleus (spinal cord)**

→ receives pain & temperature of same side of face

Masseter Reflex (Jaw reflex)

Procedure

→ **Hit with knee hammer on examiner finger placed on mentum of patient to open mouth suddenly**

→ **sudden closure of mouth occurs**

→ Sudden opening of mouth

↓

Changes position of mandible

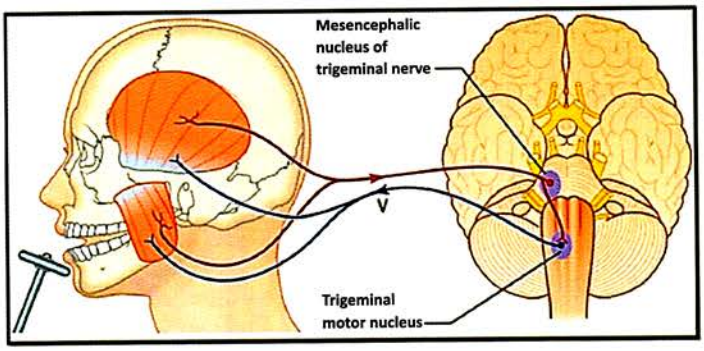
↓

Proprioception carried by mandibular branch of trigeminal nerve (sensory fibres)

↓

Mesencephalic sensory nucleus of T & N, receives proprioception

↓



Motor nucleus of T & N, activates

↓

Activates mandibular branch of trigeminal nerve (motor fibers)

↓

Masseter activated (elevates mandible)

↓

Mouth closes suddenly

Nucleus Tractus solitarius

→ present to **lateral medulla**

→ Tip will receive taste sensation (SVA) by

F → Facial nerve

G → Glossopharyngeal nerve (**from post. 1/3rd**)

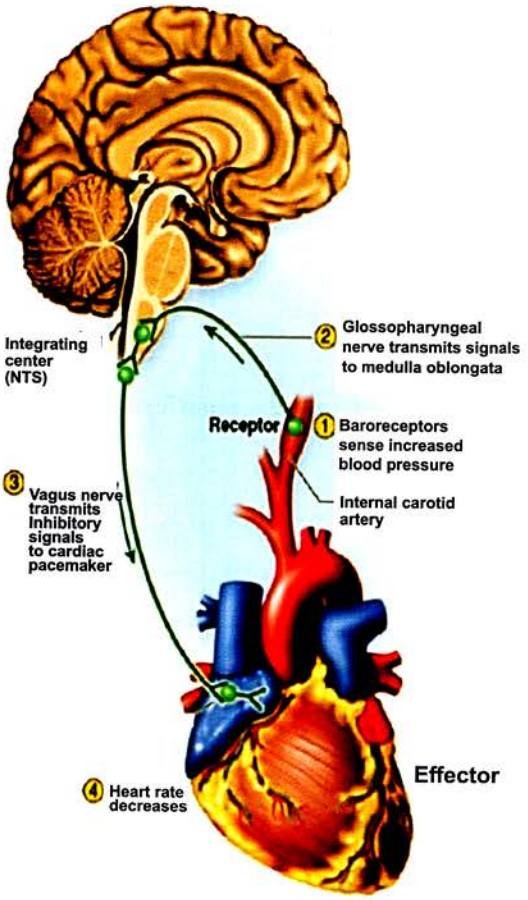
V → Vagus nerve (**post. most of tongue & epiglottis**)

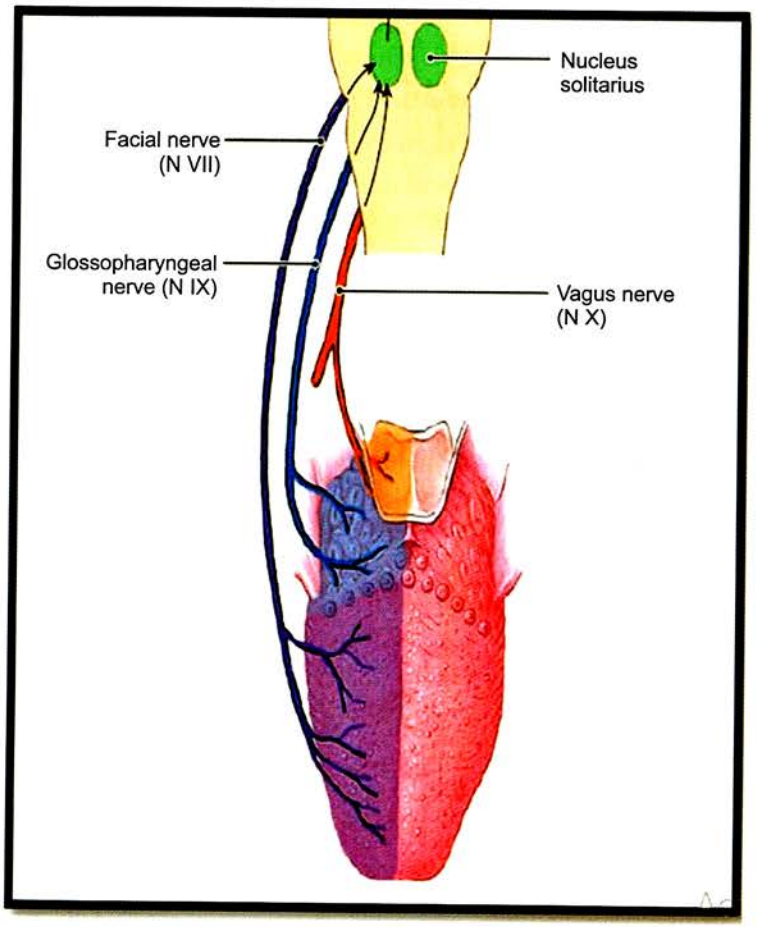
→ **Bottom receive GVA of**

Chemoreceptor & vasopressin carried by

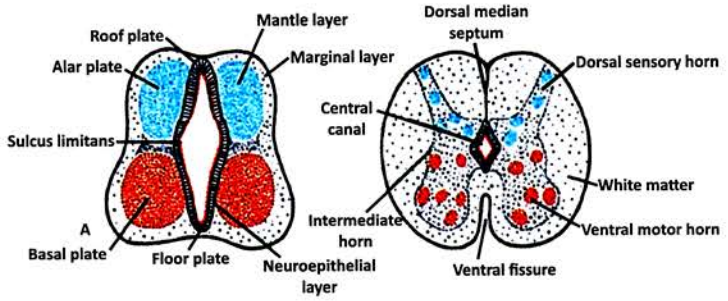
Glossopharyngeal nerve integrated in the bottom of NIS

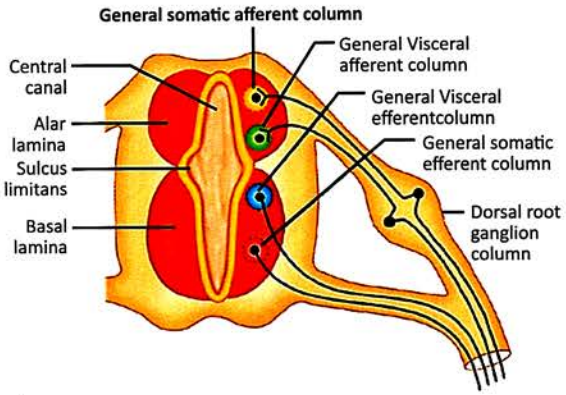
Activates vagus nerve & causes **bradycardia**





Neural Column





Ant. Basal plate → *gives ant. horn cells* → **controls skeletal muscles**

Gives lat. horn cells → **controls cardiac & smooth muscles**

Post. Alar plate → *gives post. Horn cells* → *spino thalamic tract (pain & temperature)*

Motor Components	
Somatic Motor (SM)	**Visceral Motor (VM; Autonomic)**
Motor innervation to skeletal muscles 	Motor innervation to smooth muscle, cardiac muscle, and glands 

Sensory Components	
Somatic Sensory (SS)	**Visceral Sensory (VS)**
GENERAL: Touch, pain, pressure, vibration, temperature, and proprioception from the skin, body wall, and limbs 	**GENERAL:** Stretch, pain, temperature, chemical changes, and irritation in viscera; nausea and hunger 
SPECIAL: Hearing, equilibrium, and vision 	**SPECIAL:** Taste and smell 

Motor Components

Efferent = Muscle

Skeletal /somatic muscle → **controlled by somatic nervous system**

Smooth, Cardiac } *Visceral* → **controlled by ANS**

G → General
S → Skeletal
E → Efferent → Muscles

G → General
V → Visceral
E → Efferent → Muscle

Sensory components

Somatic /parietal sensations → **outside the body wall**

Visceral sensations → **Inside the body wall**

G → General
S → Somatic
A → Afferent → Sensation

G → General
V → Visceral
A → Afferent → Sensation

Touch	angina
Pain	colicky pain
Pressure	blood pressure
Vibrations	stretch
Temperature	
Proprioception	

Smooth muscle SPASM : GVE → GVA (colicky pain)

SVE [SPECIAL VISCERAL EFFERENT]

PHARYNGEAL ARCH MUSCLES

- 1st Pharyngeal Arch → 5_3 → muscles of mastication
- 2nd Pharyngeal Arch → 7 → muscles of facial Expression
- 3, 4, 6 Pharyngeal Arches → 9, 10, 11 → muscles of Palate, Pharynx, Larynx } Speech & Swallowing

GVE [GENERAL VISCERAL EFFERENT]

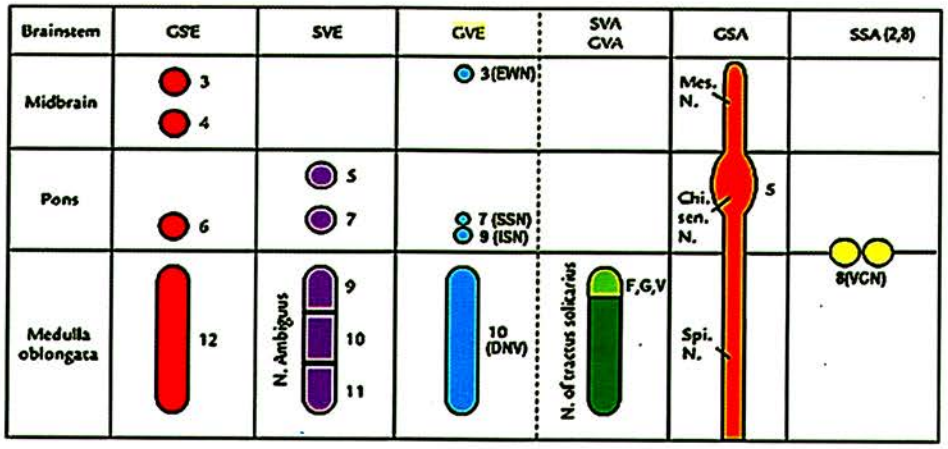
→ controlled by Para sympathetic component of ANS

PARASYMPATHETIC NERVES & NUCLEI

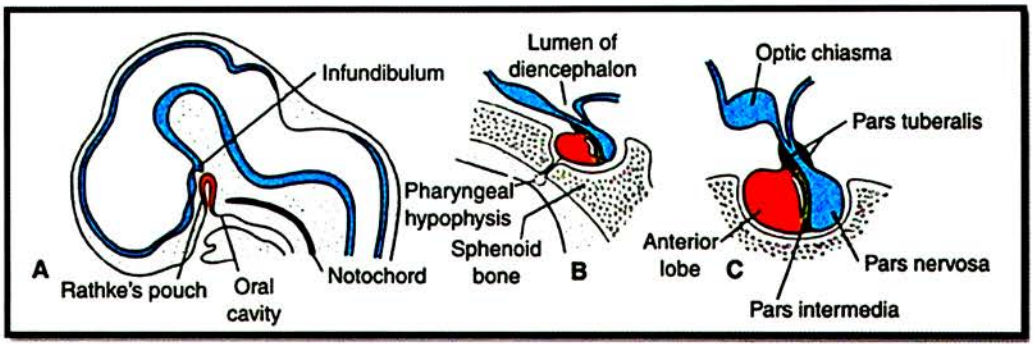
- 3 → EWN → Eye ball
- 7, 9 → Superior salivatory nucleus, Inferior salivatory nucleus → Salivary Glands
- 10 → Dorsal Nucleus of vagus → cardiac, smooth muscles & glands

TABLE: Classification of Neural Columns

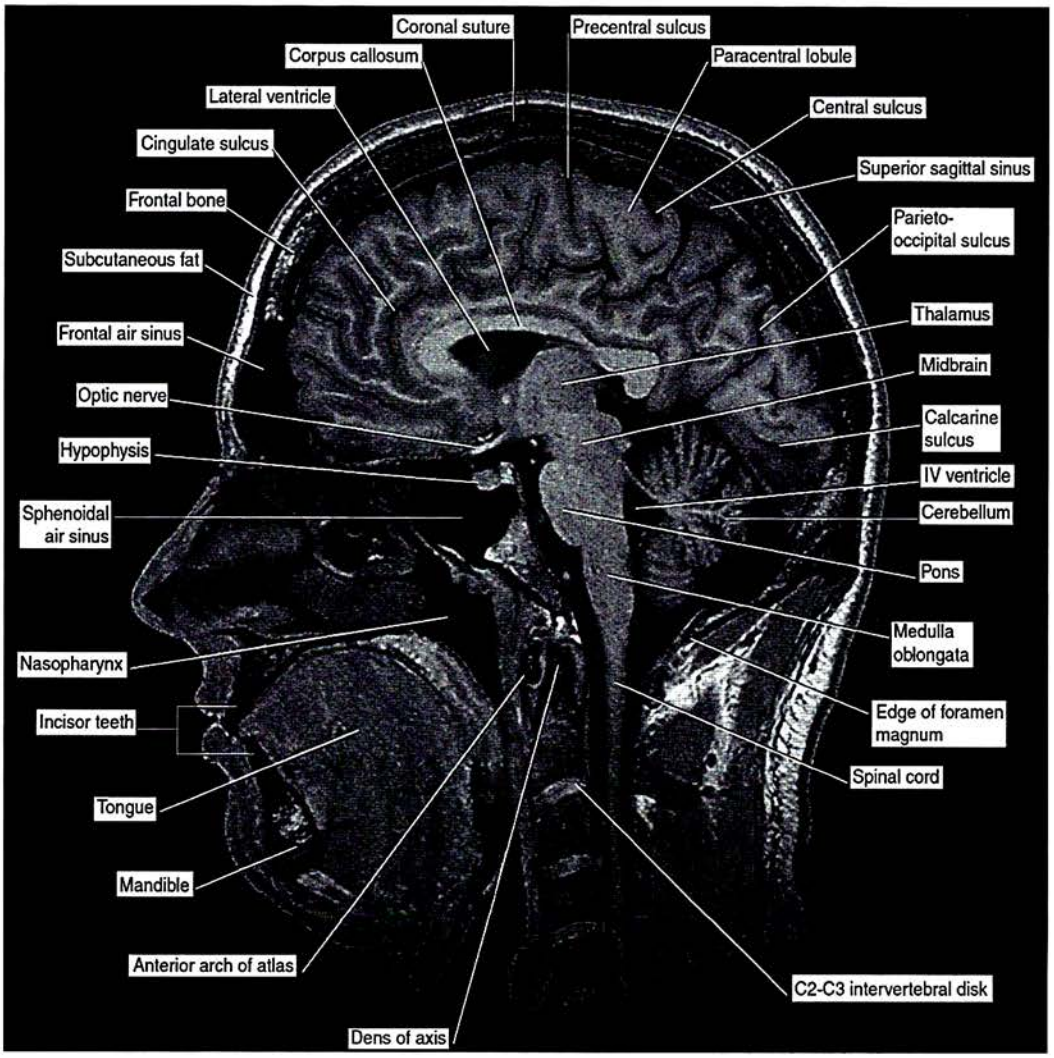
Motor (Efferent)	Sensory (Afferent)
GSE (General Somatic Efferent) • All skeletal muscles except pharyngeal arch muscles • Includes EyeBall (CN: 3,4,6) and Tongue muscle (CN:12)	**GSA (General Somatic Afferent)** • Carry general sensation such as touch, pain temperature, proprioception etc. S K. muscle sposm • Includes three sensory nuclei of CN 5
SVE (Special Visceral Efferent) • Pharyngeal arch muscles • Includes CN: 5,7,9,10,11	**SVA (Special Visceral Afferent)** • Transmit information regarding Smell and Taste • Includes CN: 1 and 7,9,10
GVE (General Visceral Efferent) • Visceral (Cardiac & Smooth) muscles and glands • Includes parasympathetic CN: 3,7,9,10	**GVA (General Visceral Afferent)** • General Visceral sensations like angina, colicky pain • Information from viscera such as carotid body & sinus
	SSA (Special Somatic Afferent) • Special Somatic sensations like Vision (eye) and Hearing & Balance (ear) • Includes CN: 2 and 8



Development of Pituitary gland



Radiological Anatomy

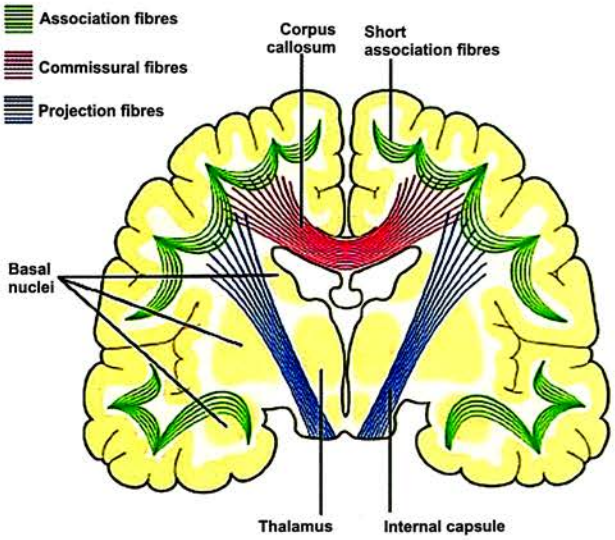


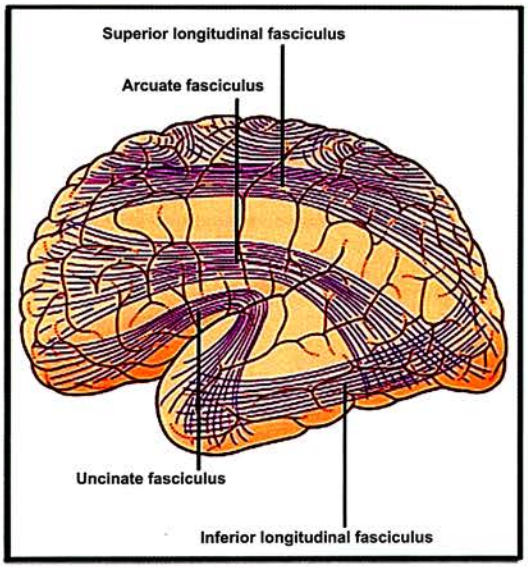
WHITE MATTER

Type of Fibres

1. **Commissural fibres** → connects rt side of brain to **lt. side of brain**
2. **Projecton fibres** → connects higher brain centre **with lower brain centre**
3. **Association fibres** → connects cerebrum on same side
   → **do not cross midline**

a.) Commissural fibres- crosses midline





b) Association Fibres

Arcuate Fasciculus

→ Seen on left side of cerebrum

→ connecting language areas (Wernicke's speech area with Broca's motor speech area)

Commissural fibres

Corpus callosum

Forceps major

→ Connects **occipital visual cortex** from one side to other

→ fibres passes in **splenium part** of corpus callus

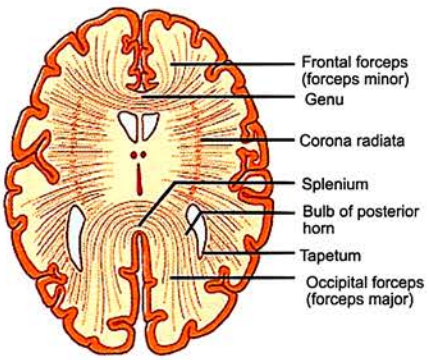
Forceps Minor

→ Connects **frontal lobe from right to left side.**

→ Fibres passes in **Genu part of corpus callsoum**

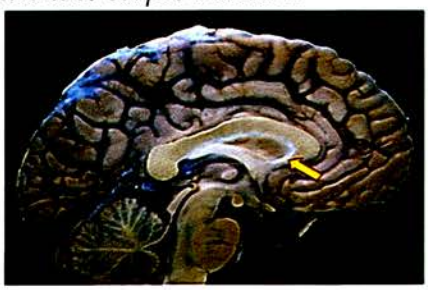
Tapetum → **connects temporal lobe**

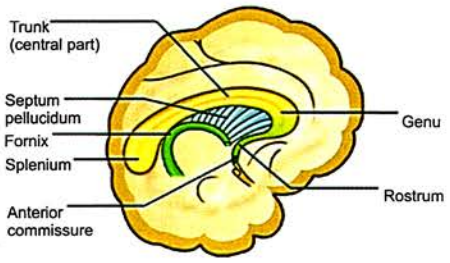
(TTT) → passes in trunk of corpus callosum

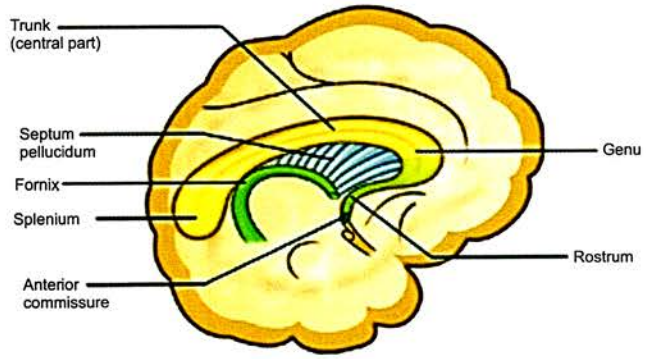


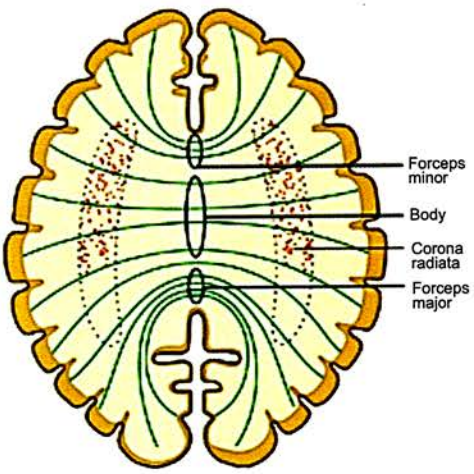
Corpus Callosum

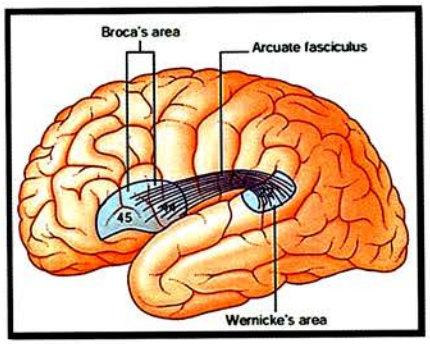
1. Rostrum (anterior)
2. Genu
3. Body /trunk
4. Splenium (posterior)

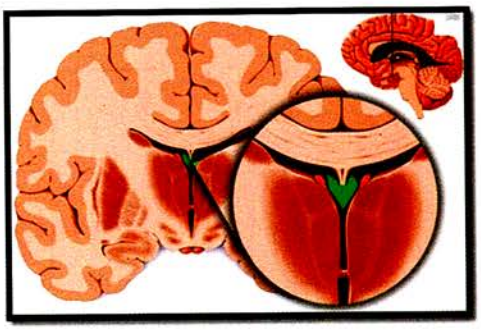








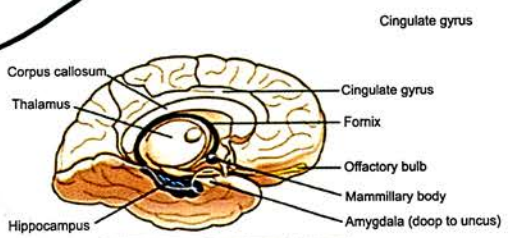


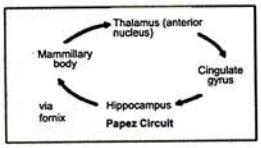


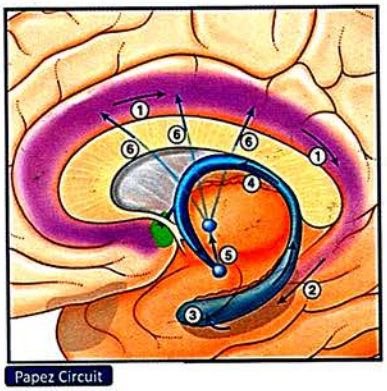
PAPEZ Circuit

AMNESIA SYNDROME
[GAINI]
FORNIX
[consolidat^{n}
of memory]
HT → ant. nucleus → THALAMUS → CEREBRUM → Cingulate gyrus
THALAMUS → Head
→ Tail
CAUDATE NUCLEUS
HIPPOCAMPUS [short term memory]
[TELENCEPHALON]
[TEMPORAL BODY]

→ part of limbic system
→ concerned ℰ memory & Emotions







Papez Circuit

ExtraPyramidal System

Basal Ganglia

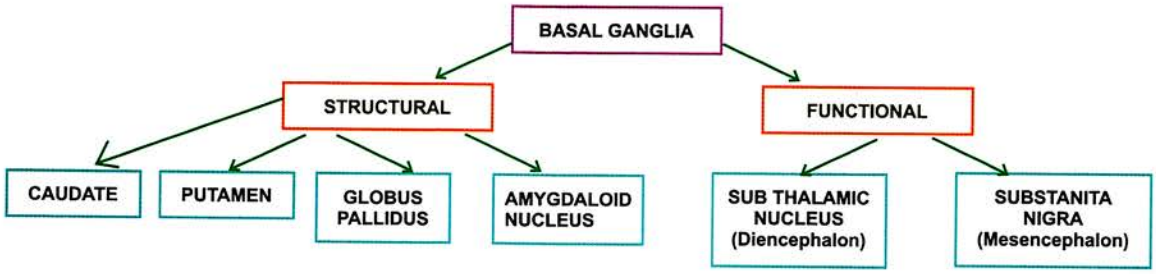
→ Misnomer

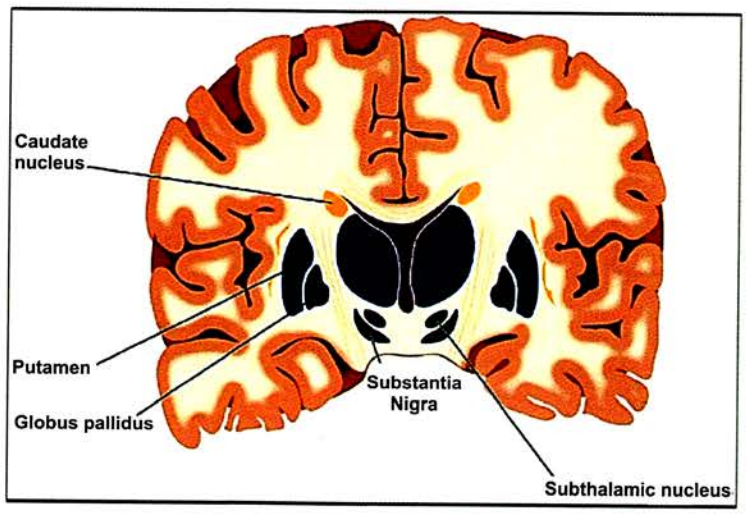
→ Part of Telencephalon

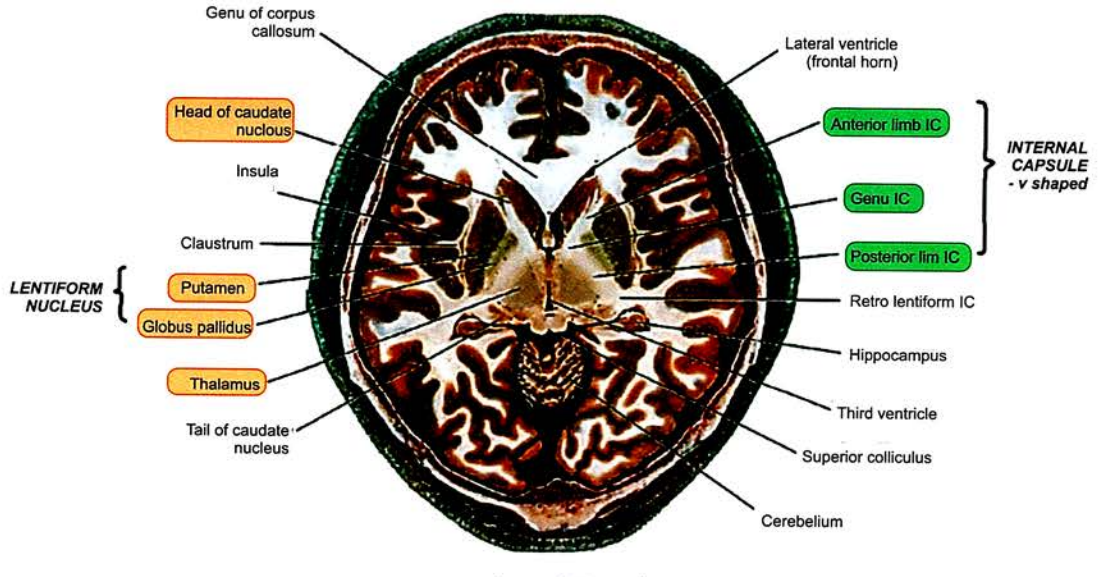
→ Nuclei

Structural Nuclei → Nuclei present in Telencephalon

Functional Nuclei → Nuclei present in Diencephalon, Mesencephalon & have functional relation







TRANSVERSE SECTION - SUPERIOR VIEW

Internal Capsule

→ Anterior limb sandwiched b/w **Lentiform (lateral) & caudate (medial)**

→ Posterior limb sandwiched b/w **Lentiform (lateral) & Thalamus (medial)**

Substantia Nigra

→ dark colored d/t melanin

→ produce **dopamine** (neuro transmitter) for **Nigro striatal Pathway**

→ **Parkinson's disease**

→ ↓ Dopamine

→ Nigro striatal pathway compromised

→ relative ↑ Ach

→ C/F

→ pill rolling tremor cog-wheel or lead pipe rigidity **hypokinesia**

→ **Rx**

1. L DOPA
2. **Trihexyphenidyl (anti-cholinergic)**

Basal Ganglia – Functions

1. Planning & programming of voluntary motor activity (extra pyramidal system)

→ (voluntary motor activity done by pyramidal system)

→ **Extra pyramidal symptoms**

→ Tremors (purposeless involuntary movements)

→ **Chorea**

→ Athetosis

→ Ballismus

→ **Hemi-Ballismus** – **seen in lesion of sub thalamic nucleus**

– **purposeless involuntary movements**

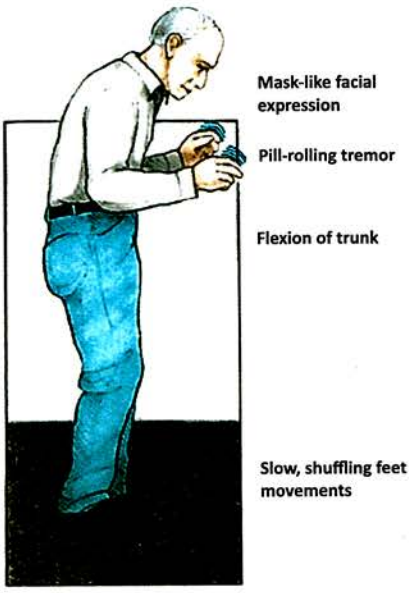
→ **In Wilson's disease – lesion of lentiform nucleus**

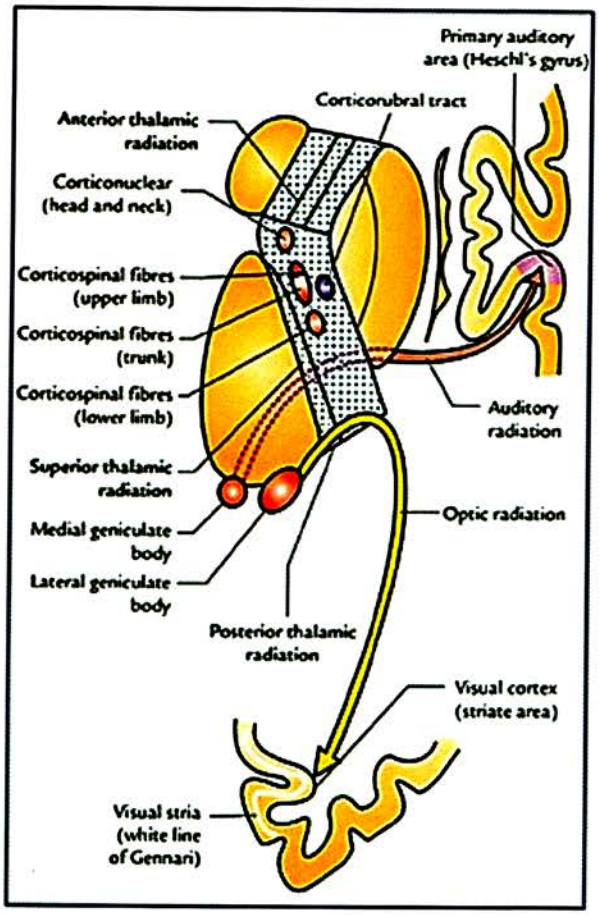
– **purposeless involuntary movements + nt**

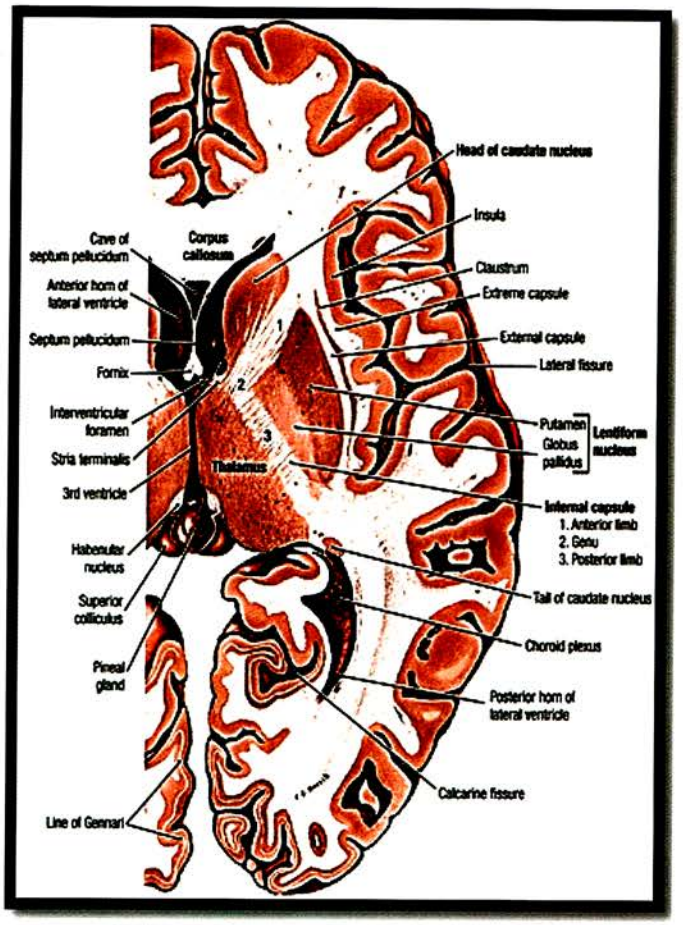
Pyramidal System → Controls fine & skilled voluntary motor activity

Parkinson's disease features

1. Mask like facial expression
2. Slow & shuffling gait → difficulty in starting & stopping movements
3. **Pill rolling tremor**
4. Cog wheel rigidity
5. Lead pipe rigidity

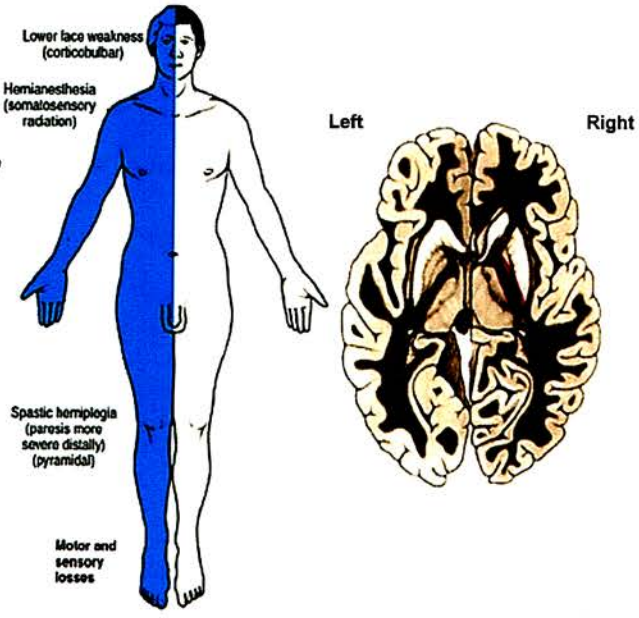






Cortico-nuclear tract → *passing through genu of Internal capsule*
→ *controls head & neck fibres*

Cortico spinal tract → *passing through posterior limb of internal capsule*
→ *controls upper limb, trunk & lower limb fibres*



Lesions of internal capsule on one side involves c/L side of the body

Only post. Limb involved → UL, trunk & LL of C/L side involved face area spared

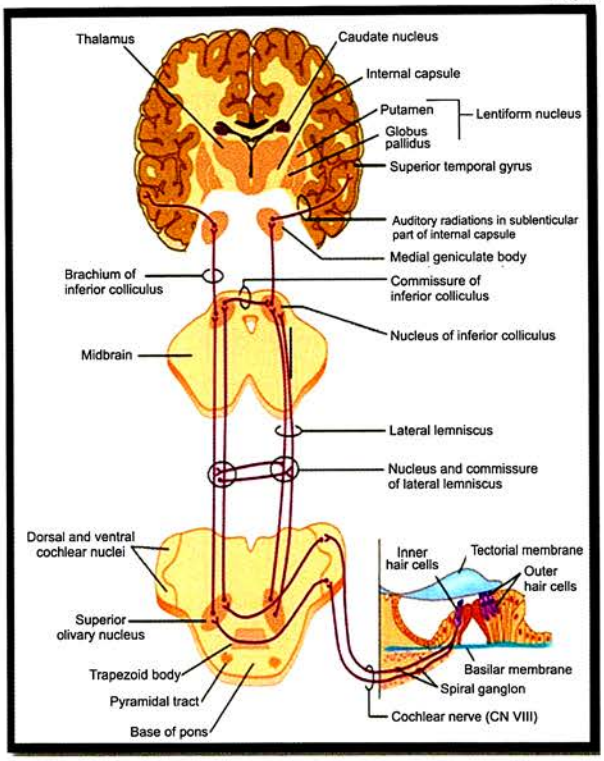
Only genu involved → Body spared

Metathalamus

Medial Geniculate Body → *concerns with auditory pathway (music)*
Lateral geniculate body → *concerns with visual pathway (light)*

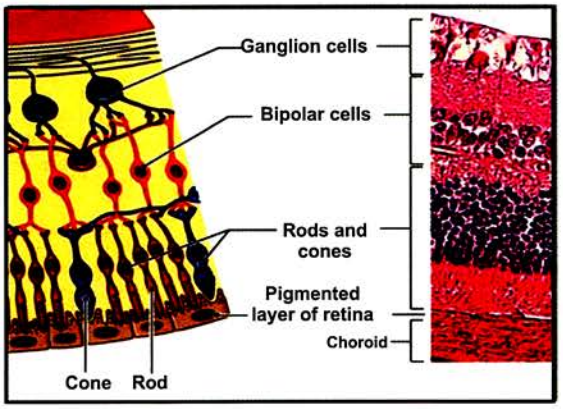
Auditory pathway / Medial Geniculate

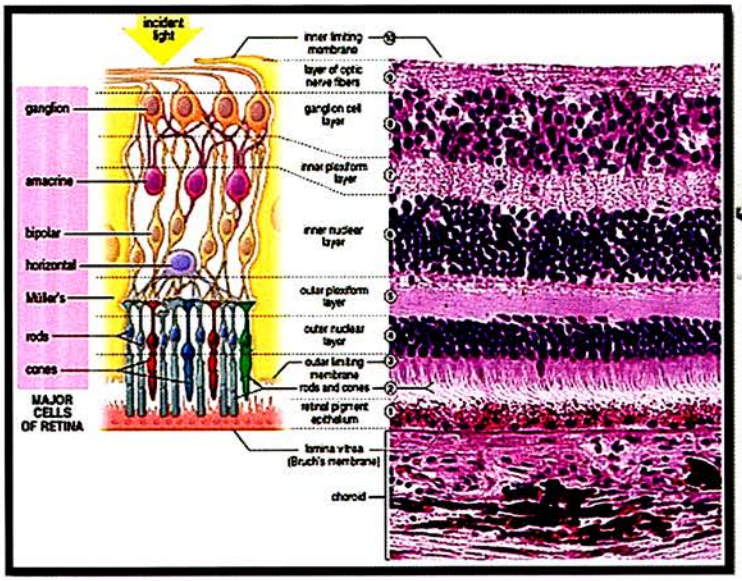
- → Fibres pass through IC & reach **HESCHL's gyrus** (sup. Temp, gyrus 41,42)
- → **Sublentiform fibres of IC are involved**
- → In posterior part of IC

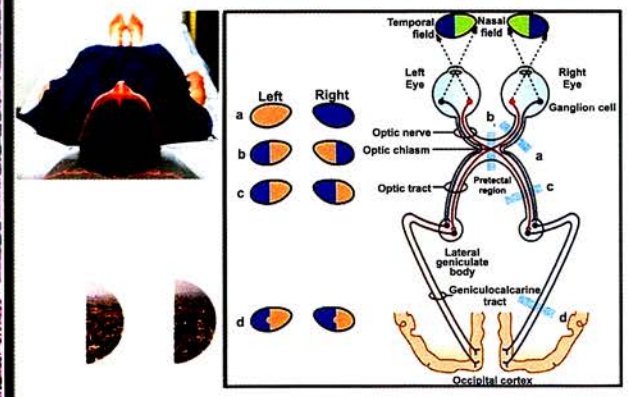


Lateral Geniculate / Visual Pathway

- → Fibres pass through IC & reach **occipital visual /striate cortex (17)**
  - Striate cortex
  - Striations of Gennari + nt
- → Aka **Geniculocalcarine tract** (starts from L&B & reaches calcarine sulcus)
- → Retro lentiform fibres are involved
- → **In post. part of IC**



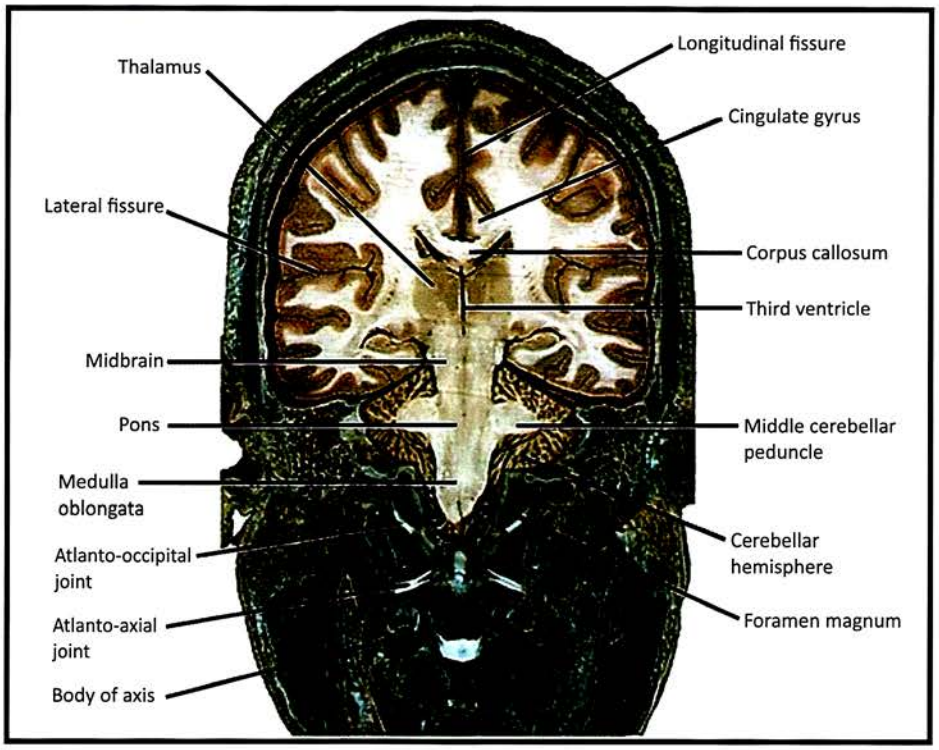


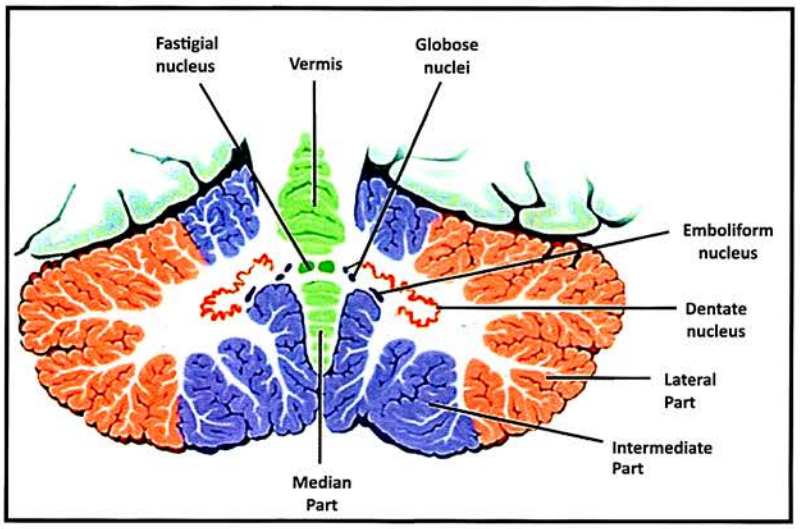


Cerebellum

→ Cerebellum present in posterior cranial fossa
- → **leaf like (foliated) → Arbor Vitae**
- → Present at roof of 4th ventricles
- → attaches to brain stem with peduncles
  - **Superior peduncle → with mid brain**
  - **Middle peduncle → with pons**
  - **Inferior peduncle → with M. oblongata**

→ **Lobes**
1. Anterior lobe
2. Posterior lobe → **latest → Neo Cerebellum**
3. Flocculo nodular lobe → **oldest → Archi cerebellum**

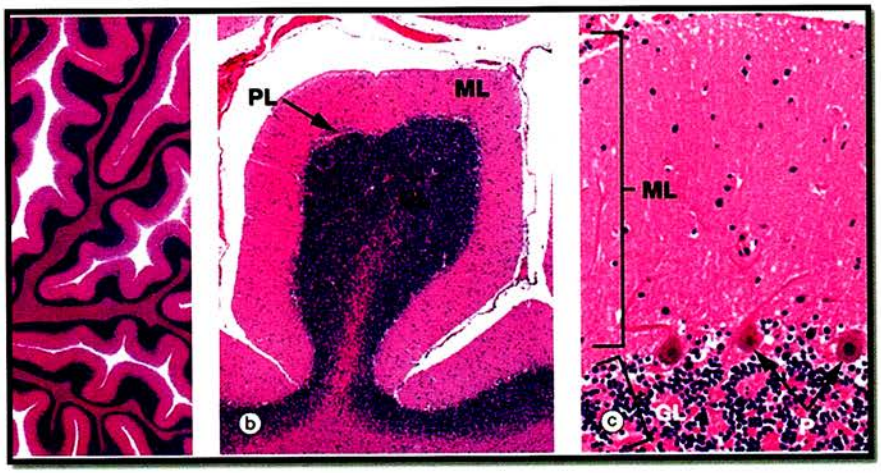




Cerebellar lesions causes ipsilateral manifestations

Cerebellar cortex – Layers

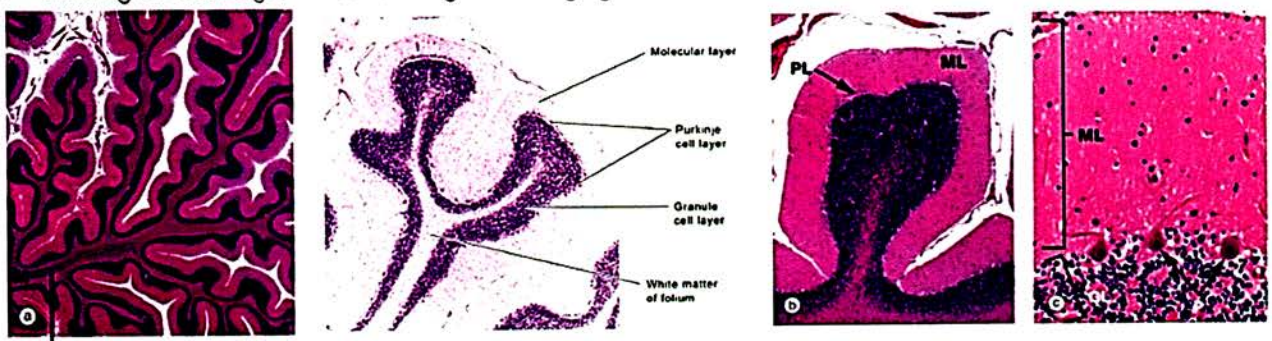
1. Molecular layer (outer)
2. Purkinje layer
3. Granular layer (Inner)



Middle cerebellar peduncle carries → ponto cerebellar tract
Superior cerebellar peduncle carries → Dentatothalamic tract
Inferior cerebellar peduncle carries → spino cerebellar tract

Cells in cerebellar cortex

1. Outer molecular layer → contains stellate & basket cells
2. Middle Purkinje Layer → contains purkinje cells
3. Inner granular layer → contains granule &golgi cells



Cerebellar pathways

→ Rt. LL moving
↓
Rt. Dorsal spinocerebellar tract activated
↓
Position sense carried towards rt. Cerebellum
↓
Cerebellum communicates with C/L thalamus via

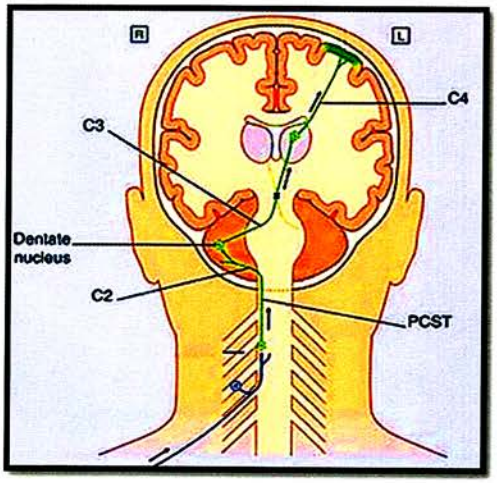
Dentate thalamic tract

↓

Thalamus communicates with left cerebrum

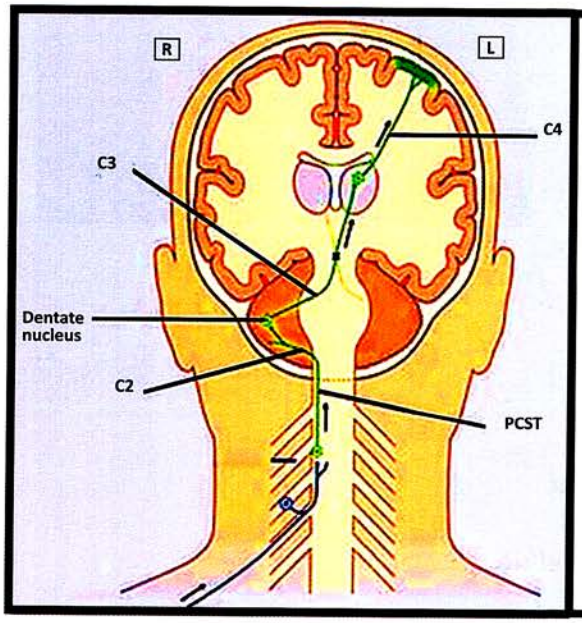
↓

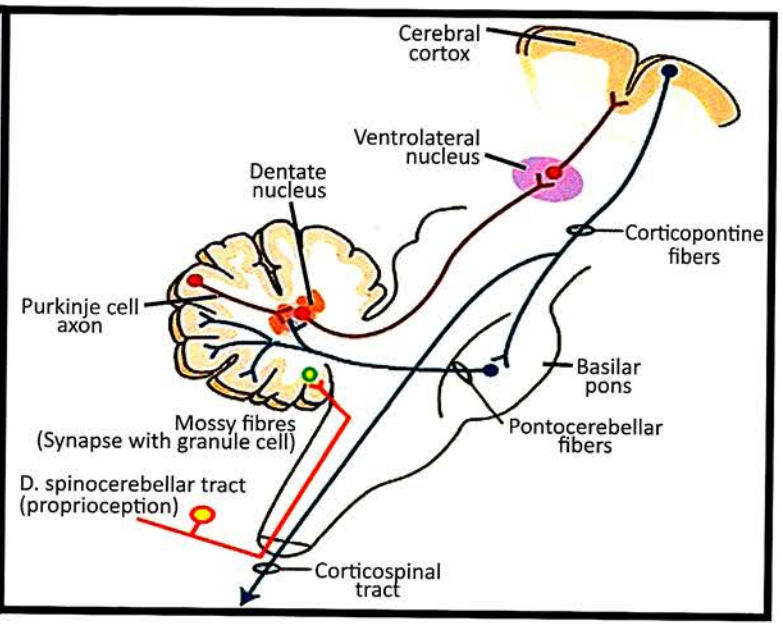
Rt. LL moved by Lt. Cerebrum via cortico Spinal tract (crossing occurs in lower medulla)

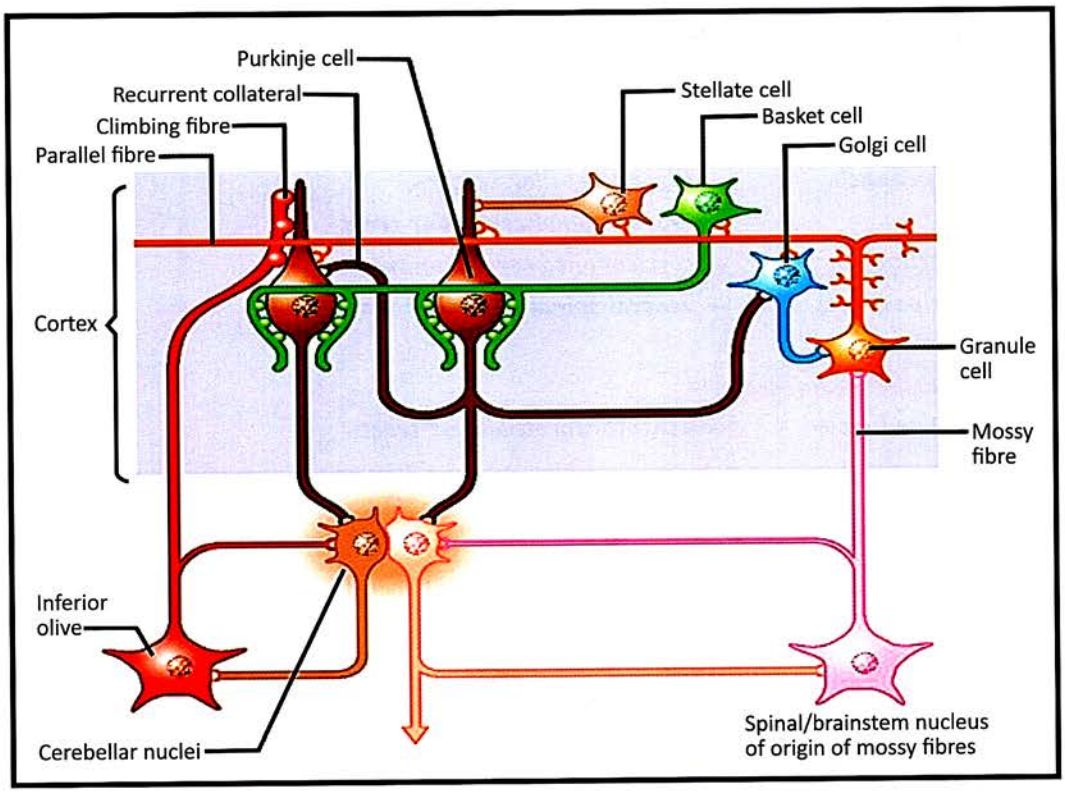


Mossy fibres

- → fibres reaching cerebellum
- → Most of mossy fibres runs as **dorsal /ventral spinocerebellar tract** & reaches ipsilateral cerebellum
- → very **few crosses midline** in spinal cord & runs as **ventral /anterior spinocerebellar** tract & Recrossing occurs within cerebellum and reaches ispilateral cerebellum
- → **Dorsal spinocerebellar tract uses inferior peduncle & reaches I/L cerebellum**
- → Ventral spinocerebellar tract uses superior peduncle & reaches C/L cerebellum but recrossing occurs & **reaches I/L cerebellum again**







Deep cerebellar nuclei (DEFG)

- D → dentate nucleus
- E → Emboliform nucleus
- F → Fastigial nucleus
- G → Globose nucleus

→ Emboliform nucleus
Globose nucleus
} Interposed nuclei

→ Dentate nucleus → most lateral, latest
→ Fastigial nucleus → most medial, oldest
Climbing fibres → comes from **inferior olivary nucleus** of medulla oblongata
Mossy fibres → **most predominant**
Purkinje Cells → **only efferent cells** of cerebellar cortex
→ **Flask shaped** with multiple projections into outer molecular layer

Cerebellar pathways

Rt. LL moving
↓
Rt. dorsal Spinocerebellar tract activated [MOSSY FIBRES]
↓
Excitatⁿ OF GRANULE CELLS
↓ via parallel fibres
Excites
STELLATE CELLS
BASKET CELLS
PURKINJE CELLS
GOLGI CELLS
↓
Information processed in 5 cells
Purkinje cells sends information to DEEP CEREBELLAR NUCLEI [uses GABA (inhibitory)]
↓
Deep cerebellar nuclei sends DENTATO THALAMIC TRACT to Thalamus

Cerebroponto cerebellar tract → via middle cerebellar peduncle,useful in **feed- Back/loop mechanism**

Incoming fibres& cerebral peduncles

Inferior cerebellar peduncle	→ **Olivo cerebellar tract**
	Dorsal spinal cerebellar tract
Middle cerebellar peduncle	→ **corticoponto cerebellar tract**
Superior cerebellar peduncle	→ **ventral spinal cerebellar tract**

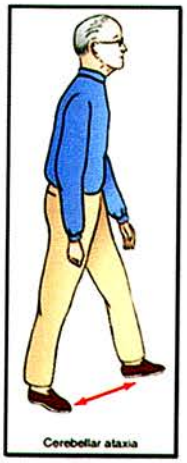
Outgoing fibres & cerebellar peduncles

Superior cerebellar peduncle	→ dentatorubrothalamic tract

Cuneo-cerebellar tract

→ For **upper limb proprioception**

→ Run via **cuneate fa**



Spinal Cord

Ant. spinothalamic tract is a crossed tract

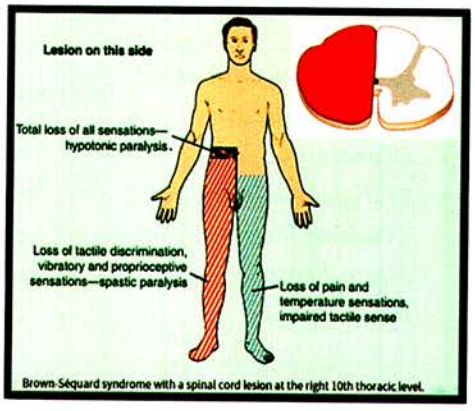
Brown Sequard Syndrome

→ **Manifestations occurs 1 or 2 segment below the lesion**

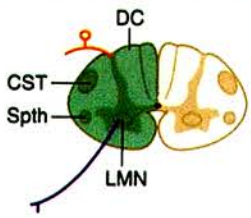
→ **Flaccid paralysis → d/t injury to LMN**

→ **Spastic paralysis below the level of lesion**

→ **d/t injury to UMN (pyramidal tract)**

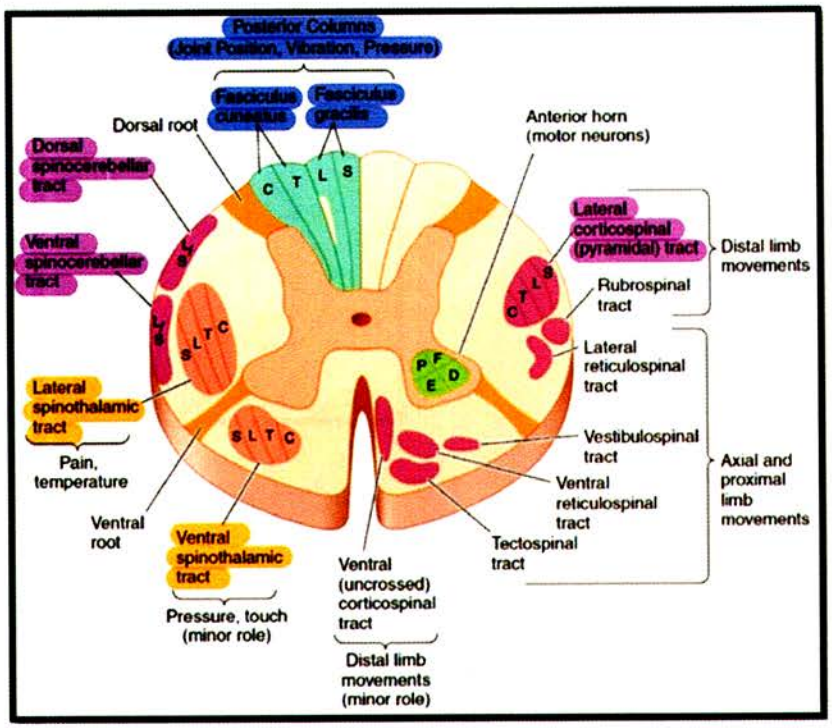


Hemisection: Brown- Sequard syndrome:-

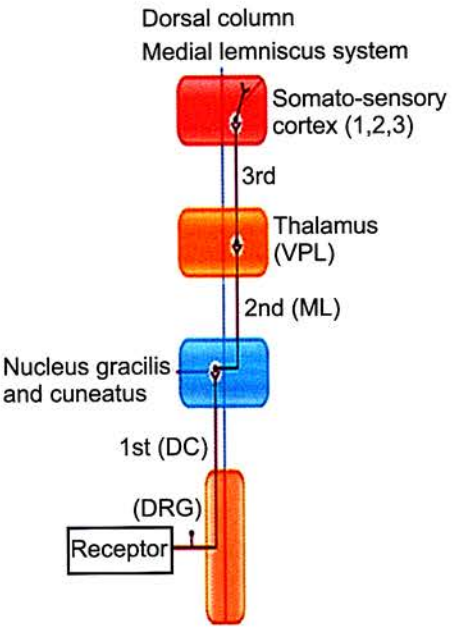


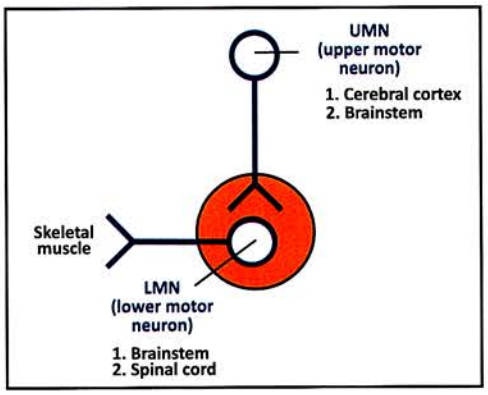
a. DC: **Ipsilateral loss of position and vibratory** Senses at and **below level** of the lesion
b. **Spinothalamic tract**: Contralateral loss of pain and temp 1-2 segments below lesion and ipsilateral loss at the level of the lesion
c. CST: Ipsilateral paresis below the level of the lesion
d. LMN: Flaccid paralysis at the level of the lesion

Spinal cord – Transverse Section



Dorsal I Posterior column carries touch & pressure



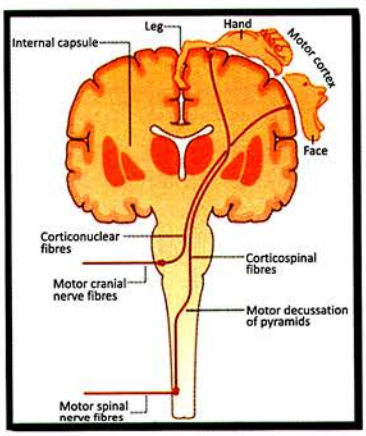


Pyramidal tract

UMN (upper motor neurons)
→ present in → cerebral cortex (mostly)
Brain stem

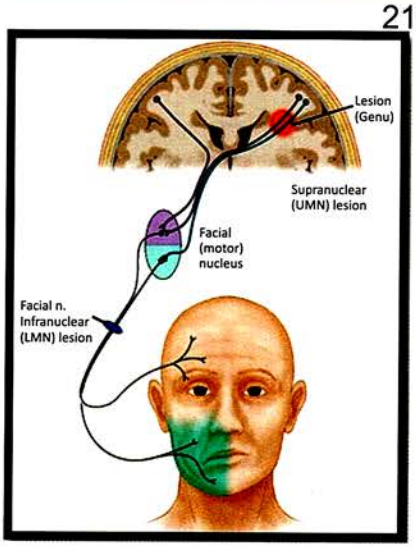
LMN (lower motor neuron)
→ present in → brain stem
Spinal cord

Brain stem → cranial nerves → control skeletal muscles
Spinal stem → spinal nerves → control skeletal muscles



→ If LMN to fire frequently → spastic pralaysis
UMN are Modulatory to LMN
→ **preferably inhibiting** but also excitatory
→ UMN palsy leads to **spastic paralysis**
→ ON LMN injury (polio virus) → **flaccid paralysis**

→ **Pyramidal system consists**
Corticospinal tract → **controls finger movements**
→ **crosses at lower medulla**
Cortico nuclear tract → controls eye movement
Cortico Bulbar tract → crosses at the level of synapse with LMN



Corticonuclear tract passes through genu of internal capsule

→ Injury of genu (UMN Injury)→ **C/L paralysis of body & lower Face is involved**

- orbicularisoris **involved** → dribbling of saliva (only has C/L innervation)

→ Orbicularis occuli is **spared** (no need of padding) (has dual innervation)

In Bell's palsy → Both upper & lower face involved (LMN Injury)→ I/L facial palsy

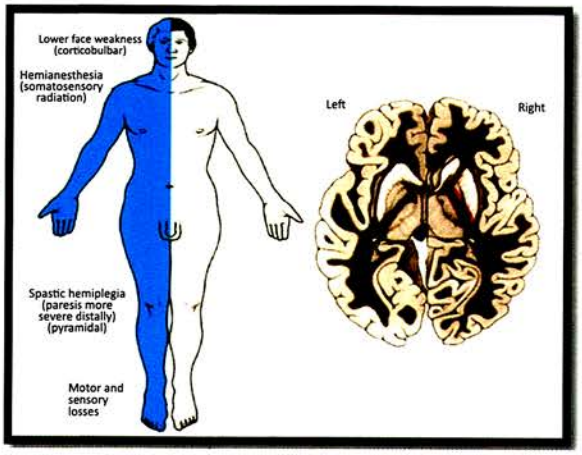
CST passes through **posterior limb of internal capsule**

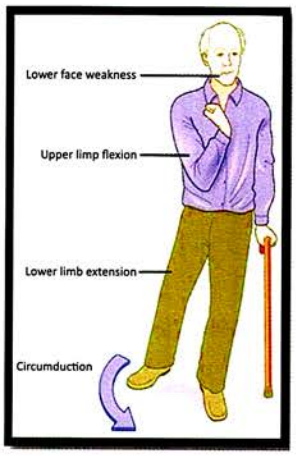
→ Injury to post.limb→ **C/L spastic paralysis**

Pyramidal decussation occurs in lower medulla (80-90%) in CST

Injury in spinal cord (after decussation) → **I/L spastic paralysis**

Boundary line B/W UMN & LMN → **Till the synapse**





Injury of Genu of internal capsule

→ **lower face weakness**

→ upper limb **flexion**

→ lower limb **extension**

→ **circumduction gait**

LMN injury (polio virus)

→ Injury after synapse

→ **Flaccid paralysis**

Dorsal column – Medial Leminiscus system

→ Dorsal column → 1 degree neuron

Medial lemniscus → 2 degree neuron

Receptor
↓
Dorsal Root Ganglion [1° neuron]
runs ipsilaterally
↓
Synapsing in NUCLEUS GRACILIS & NUCLEUS CUNEATUS in medulla
↓
MEDIAL LEMNISCUS [2° neuron] begins
runs contralaterally to reach
3° neuron in Thalamus
↓
Then passes through Internal capsule
to reach PARIETAL SENSORY CORTEX [1,2,3]

→ Receptors → Meissner corpuscle → for 2 point discrimination

Pacinian corpuscle → for pressure & vibration

→ Fasciculus cuneatus
Fosciculus gracilis
Dorsal column

→ **Fasciculus gracilis→ carries lower body (below diaphragm) sensations**
Fasciculus cuneatus→ carries upper body (above diaphragm) sensations

→ Synapse in **medial medulla**
Dorsal column (MLS) **not affected** in Wallenberg syndrome (as runs in midline)

→ Lemniscus → Bundle of axons
Medial Lemniscus→ 2 degree neuron

→ VPL (ventro-postero lateral) nucleus of thalamus → 3 degree neuron
Pass through the **posterior Limb of internal capsule**

→ **Dorsal column carries pressure, vibration & tactile discrimination**
In **left side ischemia** of post.limb of IC → **rt side loss of pressure, vibration, tactile discrimination of body.**
In **medial lemniscal injury in brain stem→rt side loss of pressure, vibration, tactile discrimination of body.**
In **brown sequard syndrome /hemisection on right side → Ipsilateral loss of sensation.**

Dorsal spino cerebellar tract

→ **Carries more axons** (more important than ventral spino cerebellar tract)
→ carries **unconscious proprioception from LL** for co-ordination of voluntary motor activity
→ lesion→ **cerebellar Ataxia**

Antero lateral spino thalamic tract

→ Runs **contra laterally**
Injury leads to **C/L manifestations**

→ Lateral spinothalamic tract carries **pain & temperature**

Spino-thalamic tract –Spinal Lemniscal System

Receptors for pain & Temperature → free nerve endings
Dorsal root ganglion
→ 1st degree neuron
→ immediately synapse on post, horn cell on same side
Post, horn cells
→ 2nd degree neuron
→ fibres from **post. horn cells cross midline** & runs as spino thalamic tract **(2nd degree neuron)**
→ **crossing occurs in ant. commissure**
Spinal lemniscus
→ lateralspinothalamic tract in brain stem → **spinal lemniscus**
→ **synapses in VPL nucleus** of thalamus → **3 degree neuron**
→ then passes through **posterior limb** or IC and relies on parietal sensory cortex (1,2,3)

Injury

1. **To post. limb of internal capsule** → C/L loss of pain & temperature
2. **Wallenberg syndrome** → C/L loss of pain & temperature
3. **Brown sequard syndrome** → **C/L loss of pain & temperature**

→ Fibres from body ascend 1 or 2 segment before they synapse & crossing midline

→ In rt side T_{10} injury → loss of sensational at T_{12} on left side

Anterior spino thalamic tract

→ runs contra laterally

→ carries crude sensations (touch & pressure) → minor role

Dorsal column carries deep touch & discriminative touch (fine touch)

D → Dorsal column

D → Deep touch

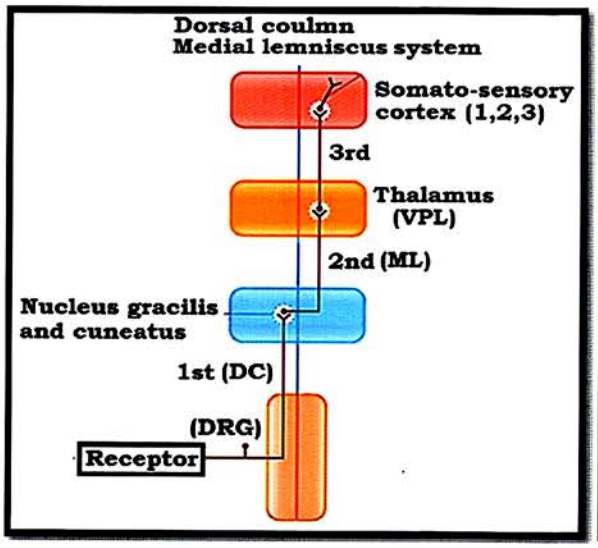
D → Discriminative touch

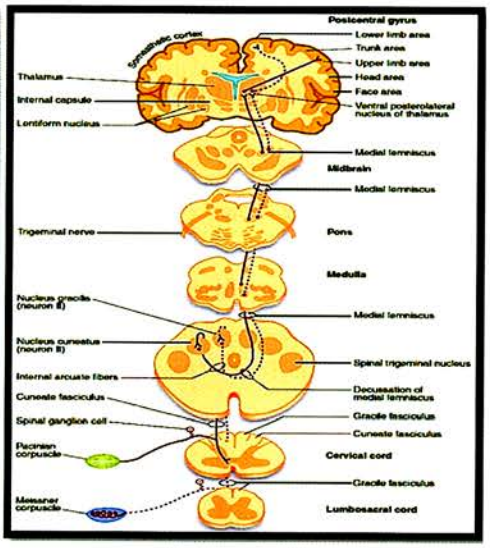
Fine touch → touching 1 point

Crude touch → touching wide area

Pacinian & meissner corpuscles are rapidly adapting receptor

Stereognosis → ability to identify the object by closing the eye with touch





Brown sequard syndrome at T10 segment on rt side

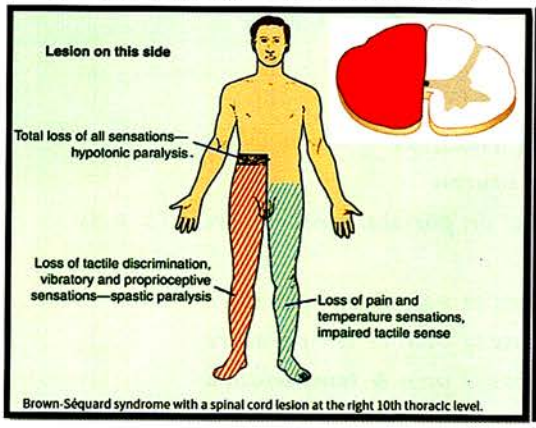
→ UMN & LMN Injury

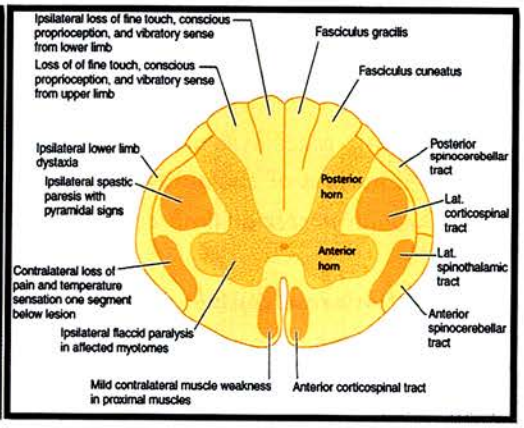
(only very few) LMN involved at T10) → Flaccid T10 Muscles

→ at the level of lesion (T10) → Flaccid paralysis

→ Below the level of lesion → spastic paralysis

d/t UMN injury → LMN free to fire

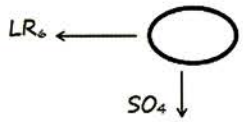


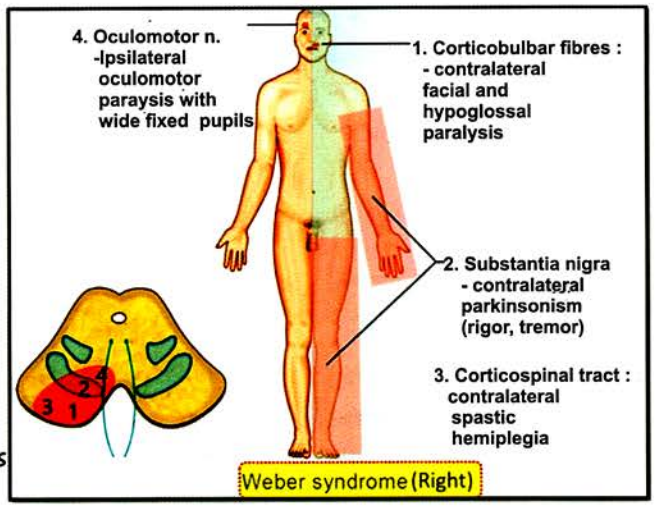


Weber syndrome (rt sided)

→ down & out eye (action of superior oblique) → down, out, intorsion)

$LR_5\ SO_4\ 3_x$





Fixed dilated pupil

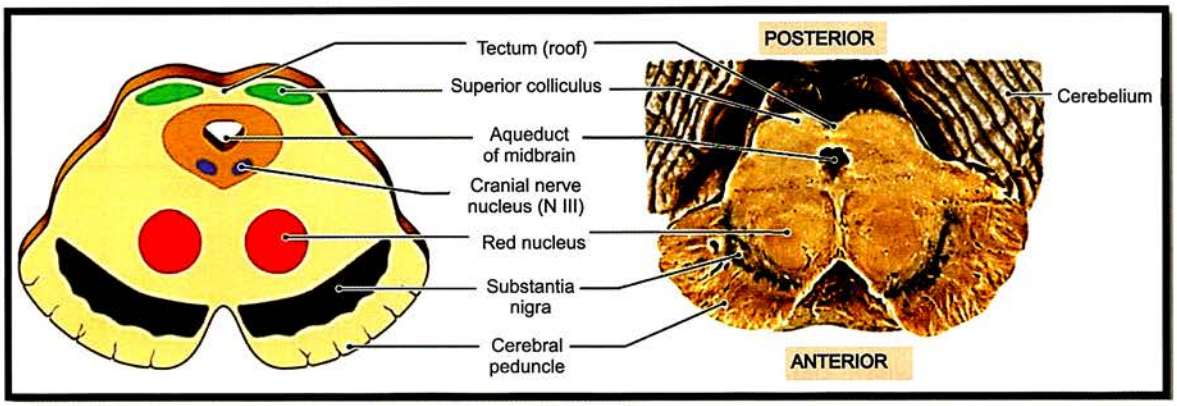
Fixed – **sphincter pupillary not working**

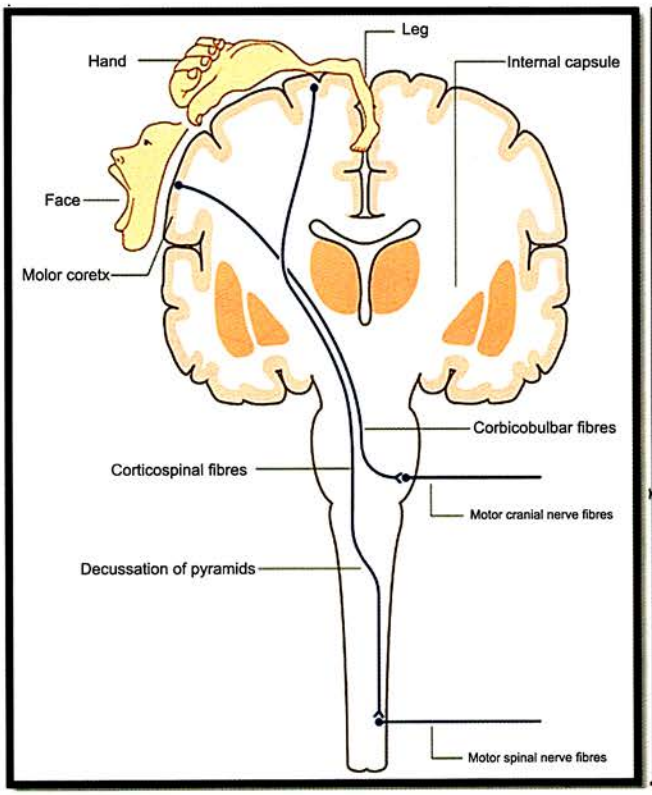
Dilated – **dilatation pupillary more powerful**

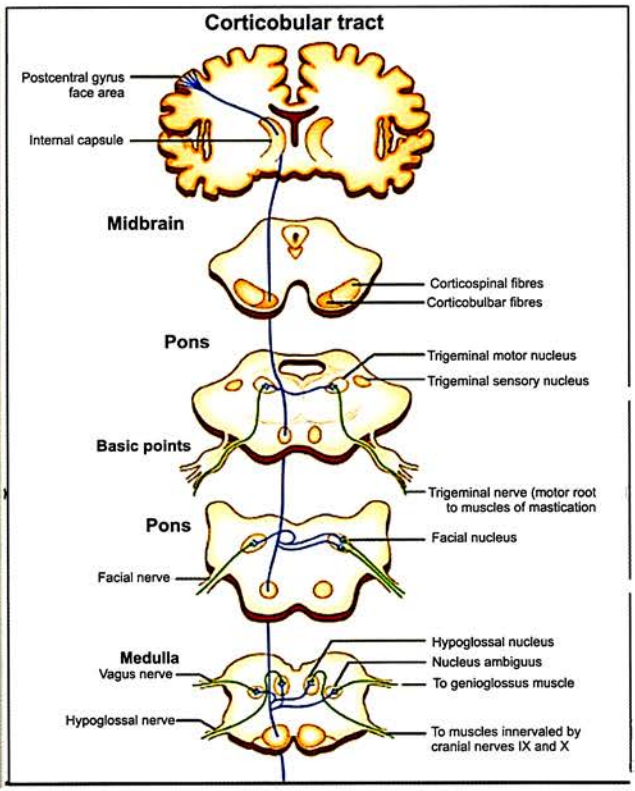
Rt. occulomotor nerve injured → rt sided down & out eye partial ptosis

→ **pyramidal tract injured → C/L spastic paralysis**

→ **C/L facial & hypoglossal paralysis**



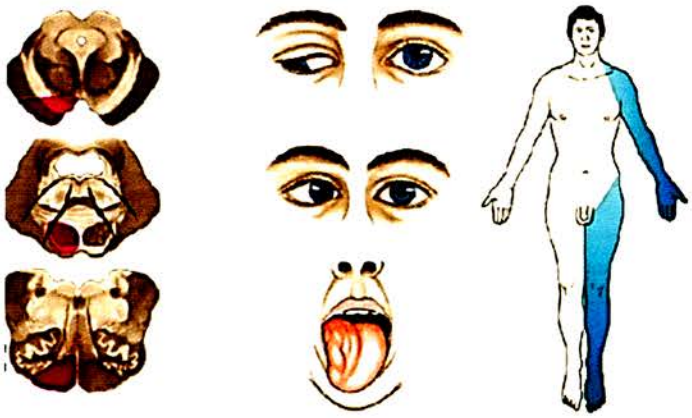


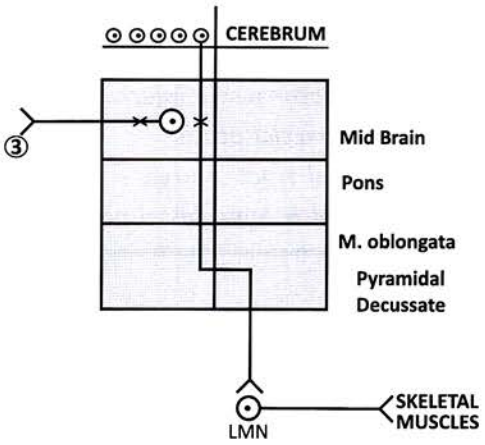


→ 6^{th}, 7^{th}, 8^{th} nerves exit at ponto medullary junctions
Most medial → 6^{th} nerve
Most lateral → 8^{th} nerve

→ 7^{th} nerve nucleus sends axons, making a **winding around abducent nucleus (6^{th})** produces rounded elevation (facial colliculus) **posteriorly at the floor of 4^{th} ventricle** at **lower pons & exits at ponto medullary junction.**

Medial brain stem lesions (Alternating hemiplegia)





Pons lesion

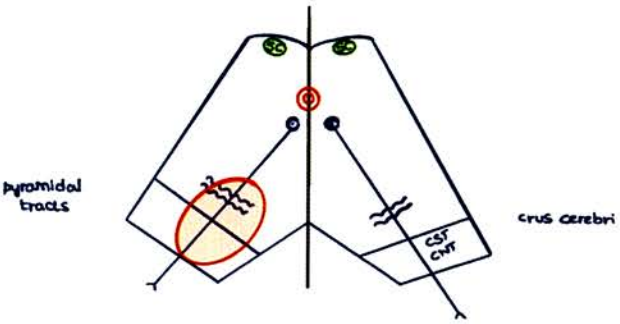
→ **6^{th} nerve involved → lateral rectus compromised → squint**

Medullary lesion (Medial Medullary syndrome)

→ 12^{th} nerve involved → Tongue palsy

Injury of midbrain

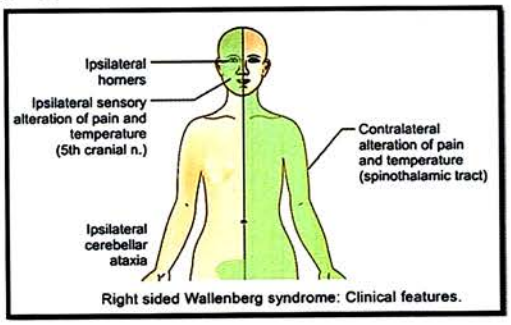
→ Branches of **basilar artery and posterior**
→ **cerebral arteries** are injured
→ **anterior mid brain syndrome**
→ **medial mid brain syndrome**
→ CN 3 injured on same side
→ **CST + CNT tract injured** → C/L paralysis
CN 5,7,12 injured C/L
Body C/L Involved
→ **Substantia-nigra involved → C/L parkinsonism**



Wallenberg syndrome

→ hypothalamo spinal pathway **compromised in lateral medulla**
→ **ipsilateral sensory loss of pain** & temperature
→ **C/L loss of pain & temperature** (spinothalamic tract injury)
→ **I/L cerebellar ataxia (dorsal spino cerebellar tract injury)**

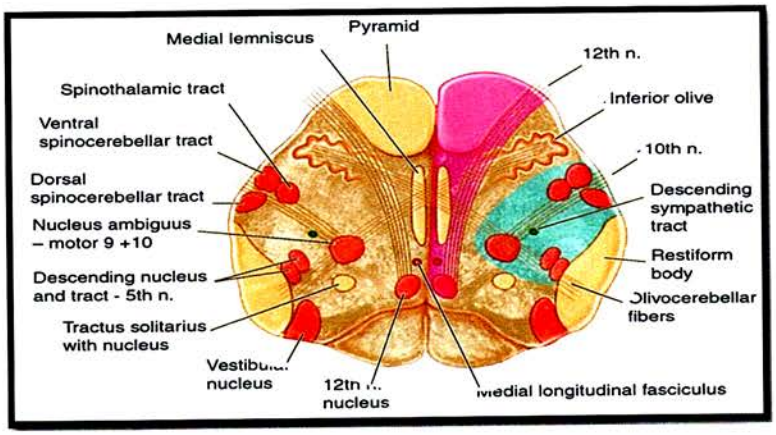
→ rt sided horner syndrome → descending sympathetic tract injury
→ Difficulty in speech & swallowing → NA injury
→ I/L loss of taste → NIS injury
→ Vertigo → vestibular nucleus injury



Right sided Wallenberg syndrome: Clinical features.

Medial medullary syndrome

→ Tongue muscle palsy → 12th nerve involved
→ Dorsal column medial lemniscal system involved
→ pressure, vibration, tactile discrimination, stereognosis, conscious proprioception
→ C/L spastic paralysis → pyramidal tract involved
→ pyramid
→ 12th nerve
→ olive
→ inferior olive nucleus
→ nucleus ambiguus → 9,10,11
→ Posteromedial to olive



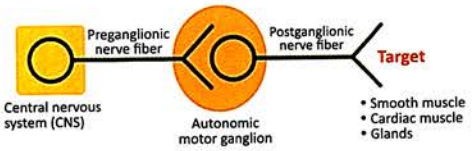
Medulla Oblangata – Transverse section

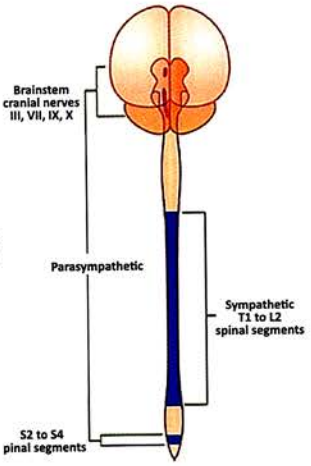
Autonomous Nervous system

→ Under the control of hypothalamus with sympathetic & parasympathetic components

Sympathetic system → Thoracolumbar flow

Parasympathetic system → cranio – CN 3,7,9,10
Sacral – S_2 – S_4
Flow





ANS- Organisation

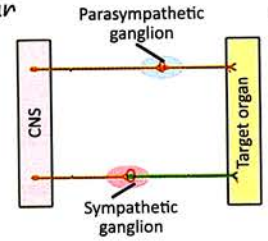
Ganglionated

1. CNS neuron → nucleus
2. PNS neuron → ganglia
3. Effectors → smooth muscle, cardiac muscle glands (secreto motor fibres)

Pre ganglionic fibres& post ganglionic fibres

→ parasympathetic ganglia are close to the target organ
→ post ganglionic fibres are shorter
→ sympathetic ganglia are close to CNS
→ pre ganglionic fibres are shorter
→ Pre ganglionic fibres are myelinated (white)

post ganglionic fibres are non myelinated (gray matter)

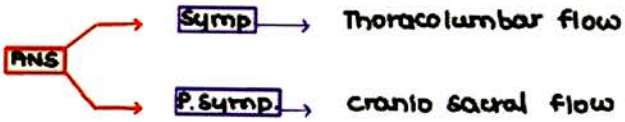


→ Sympathetic & para sympathetic neurons present in lateral horn cells of spinal cord

→ Ach → preganglionic neurotransmitter

Ach → para sympathetic post ganglionic (effector) neurotransmitter

Adr → sympathetic post ganglionic (effector) neurotransmitter



	CNS (Nucleus)	PNS (Ganglion)	Effector ↷ sm, cm ↳ glands
Para sympathetic	White (myelin)	Ach	Ach grey (non myelinated)
Sympathetic		Ach	Adr (mostly) Ach (skin - sweat glands)

Para sympathetic system

CN 3,7,9,10& Nervi Erigentes → para sympathetic nerves & white

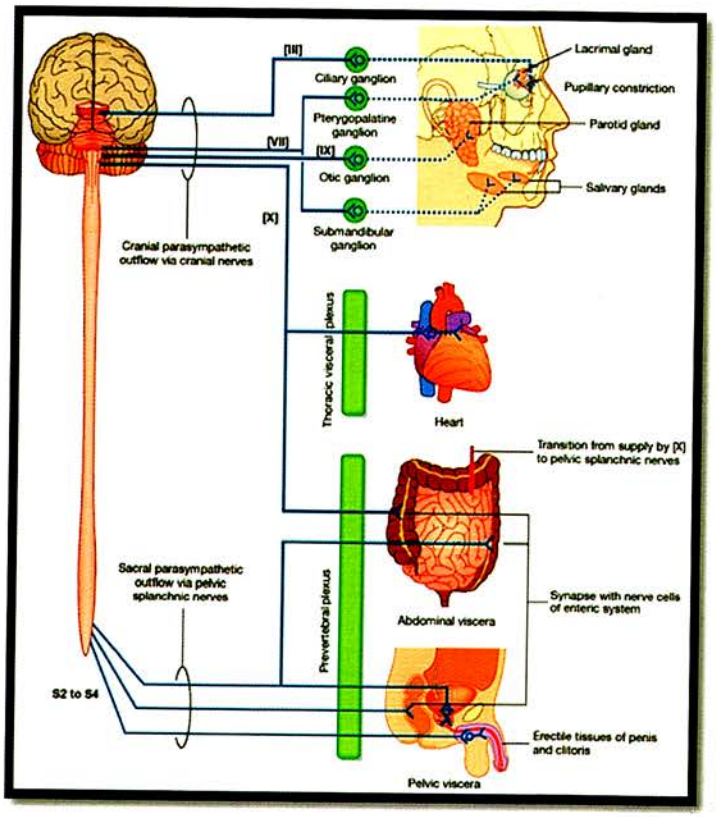
Vagus nerve

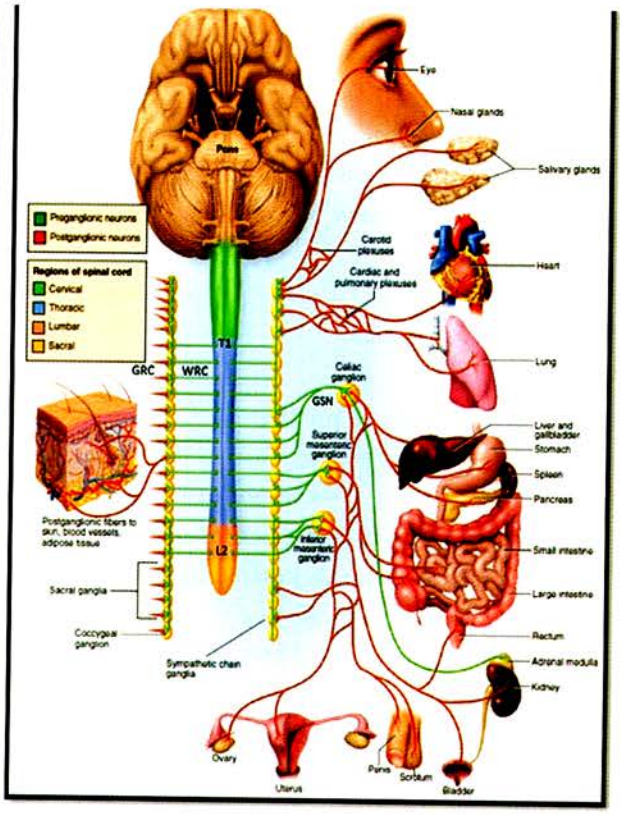
→ para sympathetic nerve

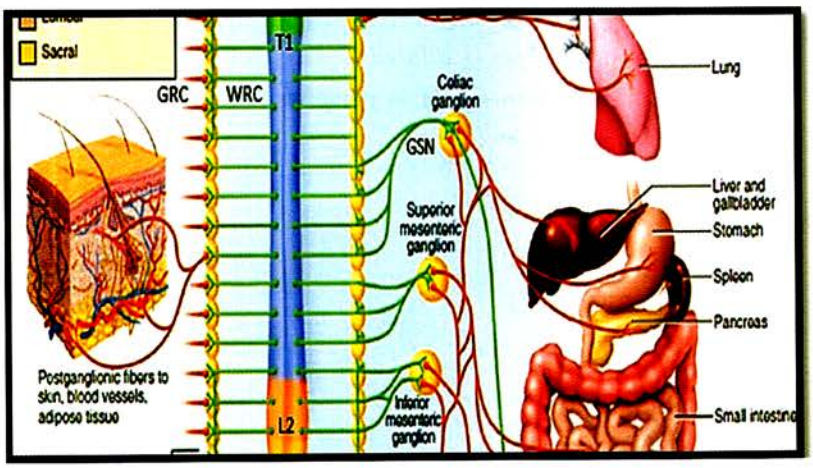
→ white → carries pre ganglionic fibres

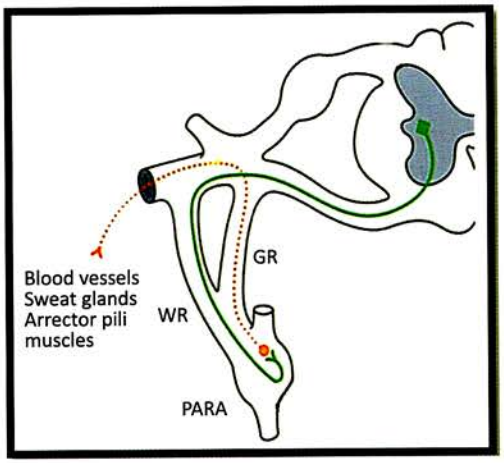
→ comes from CNS

→ cause bladder & bowel evacuation









$S_2 - S_4$ → Nervi erigentes / pelvic splanchnic nerves

→ Causes defecation & urination causes erection

CN 3 → occulo motor nerve

Contains ciliary ganglion& controls eye ball smooth muscles

CN 7 → Facial nerve

Comes from brain stem

Contains pterygopalatine ganglion
Submandibular ganglion
} controls 5 glands on face

CN 9 → Glossopharyngeal nerve

Comes from brain stem

Contains optic ganglion & controls parotid salivary glands

CN x → Vagus nerve

Longest cranial nerve & widest distribution in body

- supplies head neck → secreto motor

Thorax → bradycardia, bronchoconstriction

Abdomen → bladder & bowel evacuation

- supplies till 2/3rd of transverse colon incl. vermiform appendix

Nervi Erigentes

→ supplies hind gut including splenic flexure & rectum

→ supplies pelvic viscera (pelvic splanchnic nerves)

Post ganglionic fibres

→ No names

→ In head & neck region, they are carried by branches of trigeminal nerve topographic nerve/ location wise/anatomical nerve

Topographical / anatomical nerves → Trigeminal nerve

Functional nerves → CN 3,7,9,10, Nervi Erigentes

Comparison between parasympathetic & sympathetic nervous system

Resting
Digesting
} Parasympathetic system → Anabolic

Fight
Flight } sympathetic system → catabolic short burst Fright
→ Eyes → dilated
→ skin→ cold in periphery

Sympathetic nervous system

→ thoraco lumbar flow
→ present in LHC (lateral horn cells) of spinal cords
→ starting at T_1 spinal segment
Ending at L_2 spinal segment → 12 + 2 spinal segments (CNS)

→ **Ganglia (PNS)**

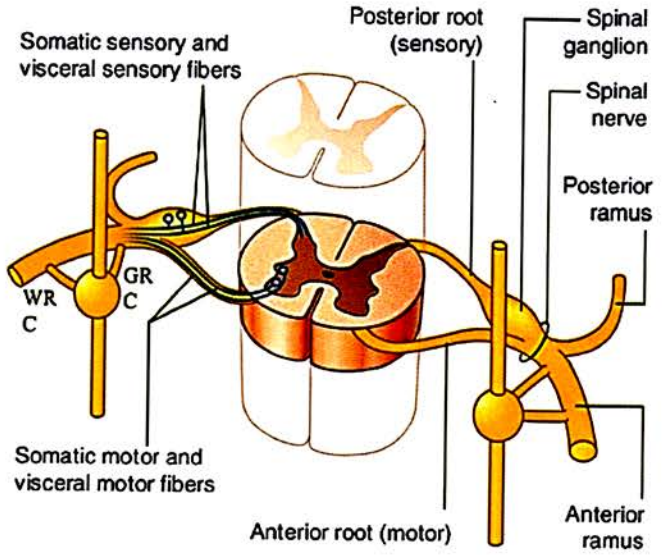
Para vertebral ganglia
→ controls skin effectors (sweat glands)
→ forms sympathetic chain
Pre vertebral /pre aortic ganglia
→ in midline & controls viscera
→ named according to branches of aorta

→ **White ramus communicantes**
→ Pre vertebral fibres
→ Myelinated fibres → White

→ **Gray ramus communicates**
→ Post vertebral fibres
→ non – myelinated fibres → grey

→ some fibres by passing para vertebral ganglia to synapse in prevertebral ganglia
→ greater splanchnic nerve (GSN) — Least splanchnic nerve
Lesser splanchnic nerve (LSN) — Lumbar splanchnic nerve

Ramus communicantes

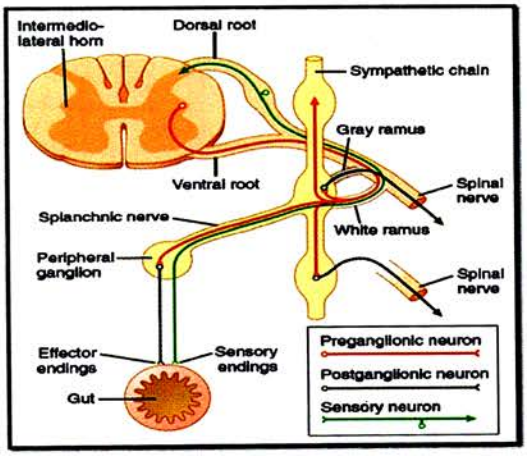


→ ventral root + doral root
↓
Spinal nerve

→ Spinal nerve connected to sympathetic ganglia by → Distal White Ramus communi - cantes & proximal Grey Ramus communicantes

Pre vertebral ganglia → Supplies viscera

Greater Splanchnic nerve



→ Comes from CNS → white (myelinated) → uses WRC

→ comes from T5-T9 spinal cord

→ pre vertebral fibres bypassing sympathetic chain to synapse in pre vertebral ganglia (celiac ganglia)

→ Celiac ganglia controls foregut derivatives (stomach)

→ ↓ Peristalsis → distention pain (carried by GSN)

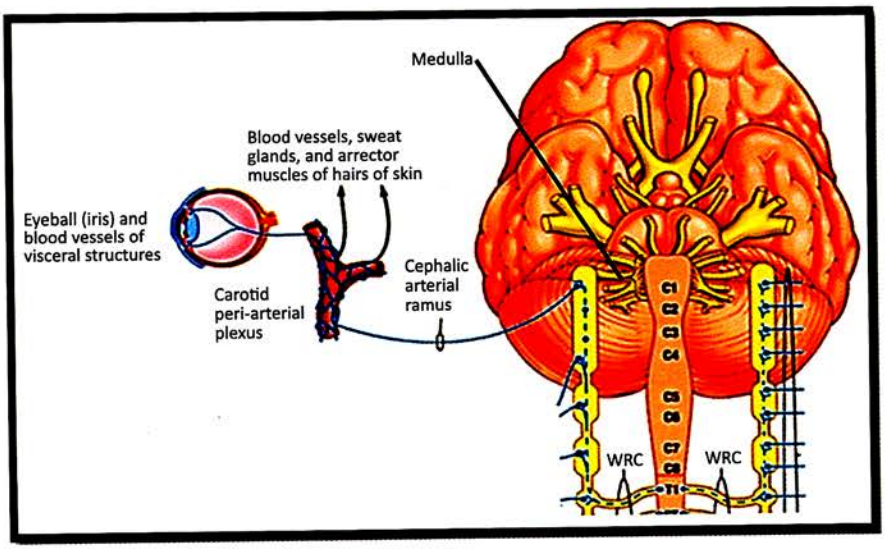
→ GSN is both sensory (GVA) & motor (GVE)

→ Pre ganglionic fibres of sympathetic system → shorter Post ganglionic fibres are carried by branches of celiac artery

No. of pre ganglionic sympathetic fibres (WRC)→ 14 + 14 → 28

No. of post ganglionic fibres → 1:30 → 30 times of pre ganglionic fibres

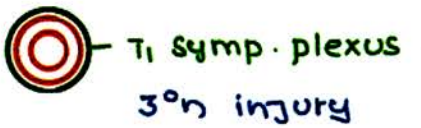
Horner syndrome



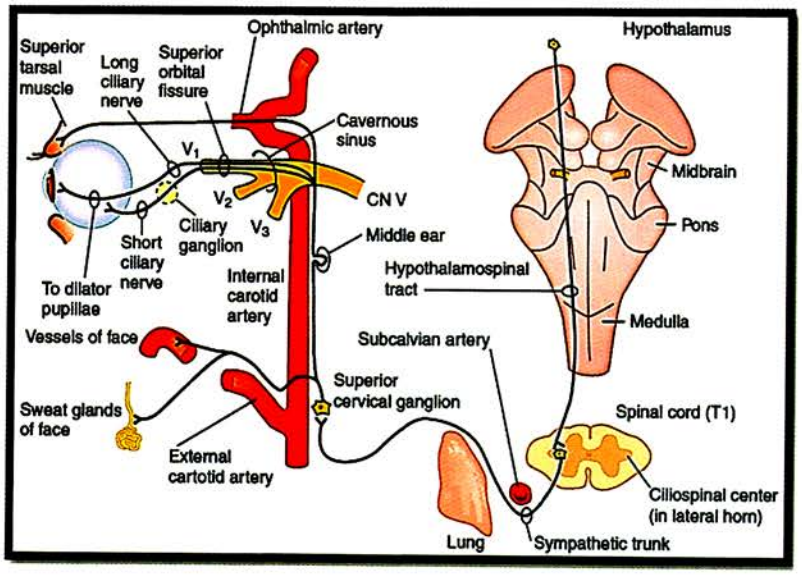
Cavernous sinus pathology->Internal carotid artery dissection

C/F

1. Ptosis +
2. Miosis +
3. Anhidrosis +/-
4. Nasal congestion
5. Conjunctival congestion
6. Skin becomes red



Rt Horner syndrome



Ptosis

→ *superior Tarsal muscle miller muscle paralysis* → **partial ptosis**

→ *d/t T1 Sympathetic fibre compromisation*

Miosis

→ *Sphincter pupillae become more powerful*

Dilator pupillae paralysed (supplied by T1 symp. Fibres)

Enophthalmas (Sunken eye ball)

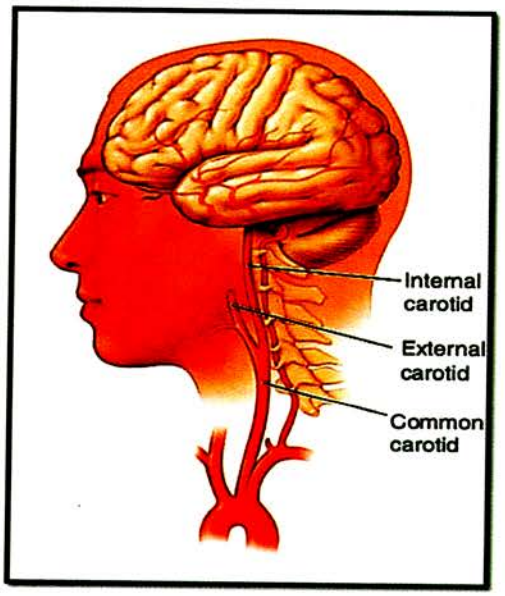
→ *paralysis of orbitalis* **(supplied by T1 sympfibres)**

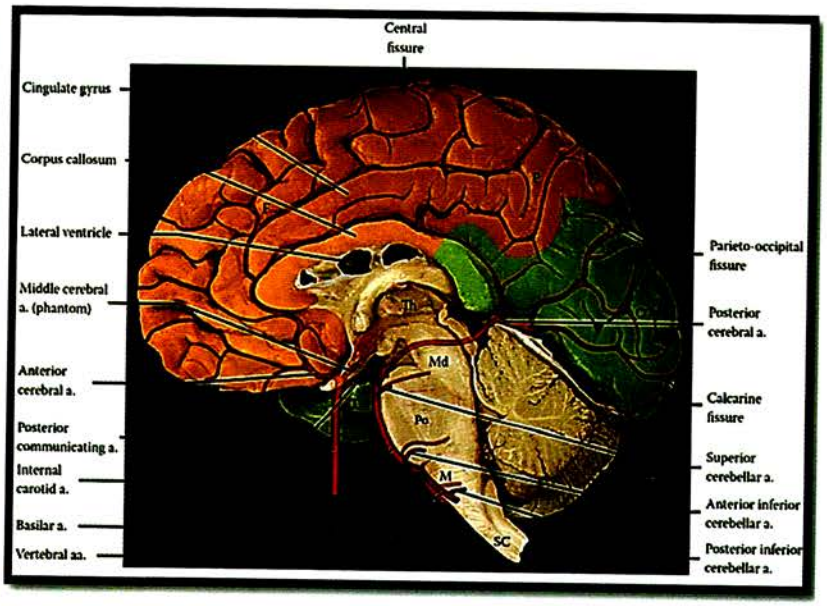
→ *Orbitalis normally pushes the eye ball out of socket.*

Nasal congestion
Conjunctival congestion
Skin becomes red

} *d/t* **vasodilation** *(hyperemia)* *as T1 sympathetic* **vasoconstriction** *is gone*

Arterial supply of brain





Labyrinthine artery

→ supplies ear

→ in 80%, it is branch of Ant. inf. Cerebellar artery of basilar artery

Circle of Willis

→ at base of brain in inter peduncular (cerebral) area at subarachnoid space

→ contributed by

1. Internal carotid artery (anterior)
2. Vertebral artery (posterior)

Vertebral arteries

→ enter the control cavity by passing **foramen magnum**

→ 2 vertebral arteries join to form → **basilar artery at base of pons**

→ Branches

1. ② Posterior Inferior Cerebellar artery [PICA] One on each side
2. ② Anterior Spinal arteries ——later——→ ① anterior Spinal artery in midline supplies ant. 2/3rd of Spinal cord
3. ② Posterior Spinal arteries → supplies post. 1/3rd of Spinal cord

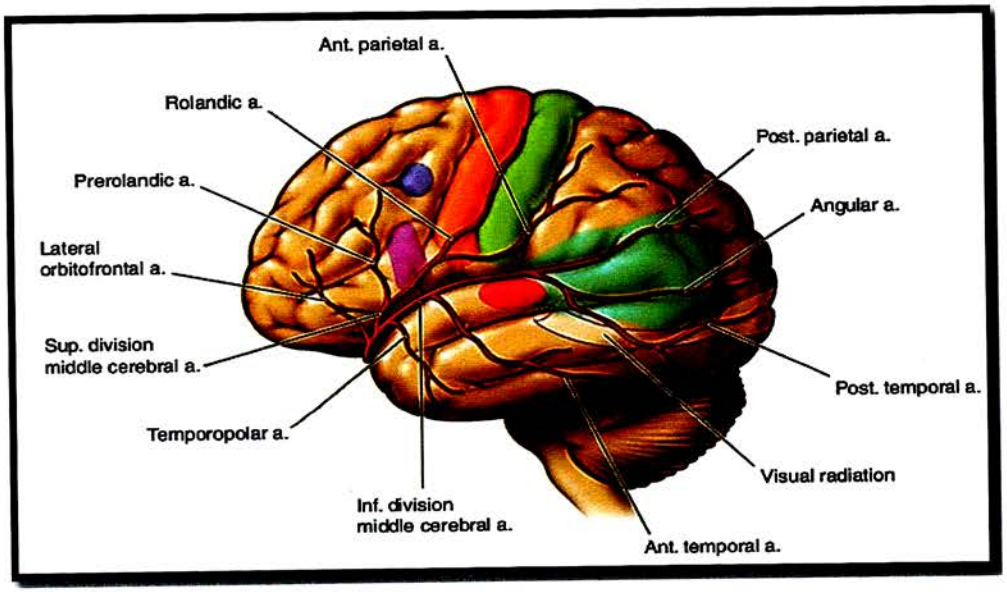
Basilar Artery

→ supplies the pons, upper medulla, mid brain

→ **branches**

1. **Anterior inferior cerebellar artery** (AICA)
   → Gives labyrinthine artery (in 80%)
2. **Labyrinthine artery** (in 20%)
3. **Superior cerebellar artery to cerebellum**
4. **Posterior cerebral artery** → supplies posterior cerebrum & communicates with post. communicating br. Of ICA & forms Circle of Willis

→ In **berry aneurysm** on posterior communicating artery, the most commonly damaged nerve is occulomotor nerve.



Berry Aneurysm

→ present in **subarachnoid space**
→ leads to **subarachnoid hemorrhage**
→ CSF mixes with blood

ICA branches

1. Anterior cerebral artery → **supplies ant. cerebrum**
2. Middle cerebral artery → **goes to lateral sulcus of brain**
3. **Posterior communicating artery contributes to circle of Willis**
4. **Ophthalmic artery → supplies eye ball**

Anterior choroidal artery → supplies post. limb of internal capsule genu of IC supplied by direct br. Of ICA.

Basilar artery	Pons Upper medulla Mid brain
PICA	Posterior cerebellum Lateral medulla
Posterior cerebral artery	Posterior cerebrum **Occipital visual cortex/striate cortex calcarine sulcus** Mid brain Thalamus
Posterior communicating artery	Thalamus
Ant. cerebral artery	Ant. cerebrum **Medial cerebrum (major contribution)** Para central lobule **Lateral cerebrum (pelvis, perineum)**
Middle cerebral artery	Lateral cerebrum (major contribution) **Wernicke's broca's areas** Macular area

PICA occlusion leads to → lateral medullary / Wallenberg syndrome
Wallenberg syndrome resulted from Vertebral artery occlusion (more often) > PICA occlusion
Medial medullary syndrome is d/t occlusion of Ant. spinal artery

Medulla oblongata supplied by 11 arteries: **superior cerebellar artery do not supply**

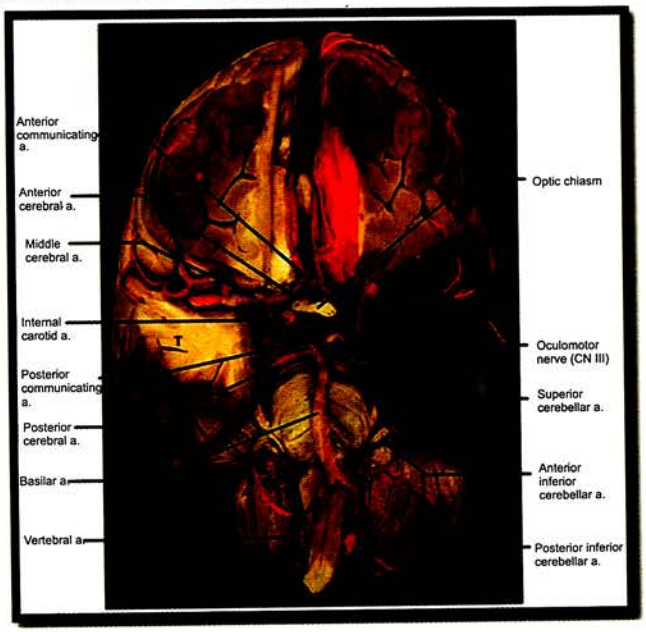
→ Basilar artery → **upper medulla**
→ 2 AICA
→ 2 PICA
→ 2 vertebral arteries
→ 2 Ant. spinal arteries
→ 2 post. Spinal arteries

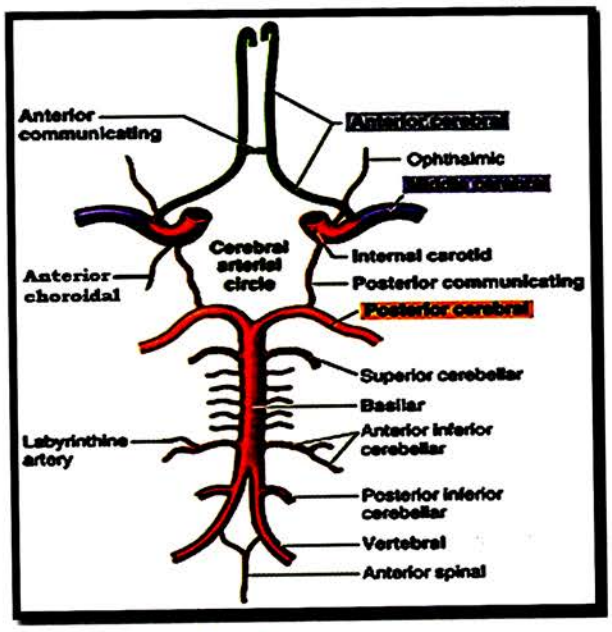
In berry aneurysm on posterior communicating artery, the most commonly damaged nerve is occulomotor nerve

Occulomotor nerve & trochlear nerve

→ comes from **midbrain**
→ sandwiched **b/w posterior cerebral artery & superior cerebellar artery**
→ mid brain has **dual blood supply**

Circle of Wills → 9 arteries

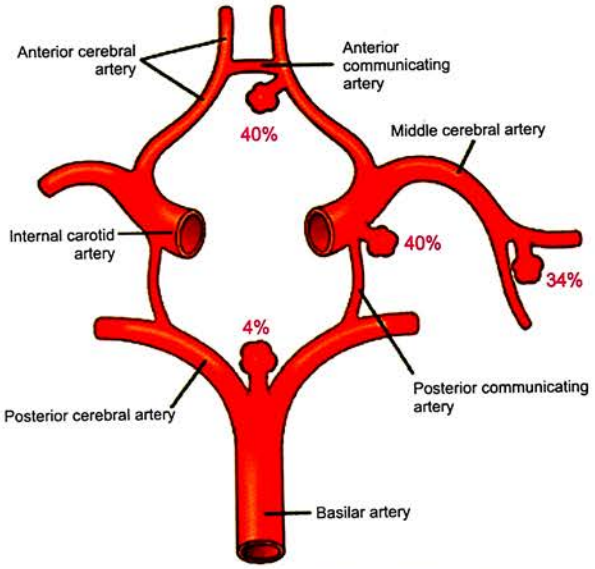


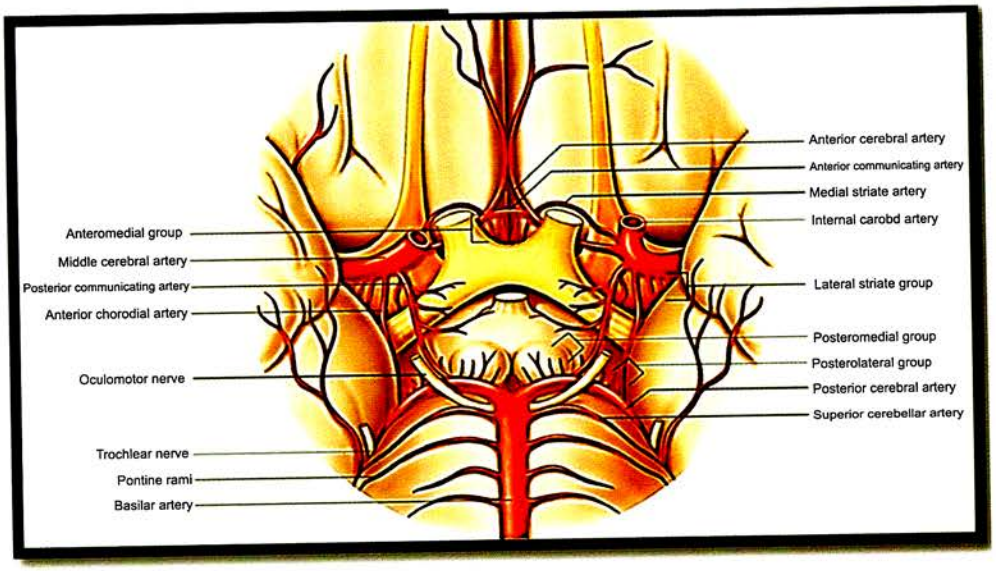


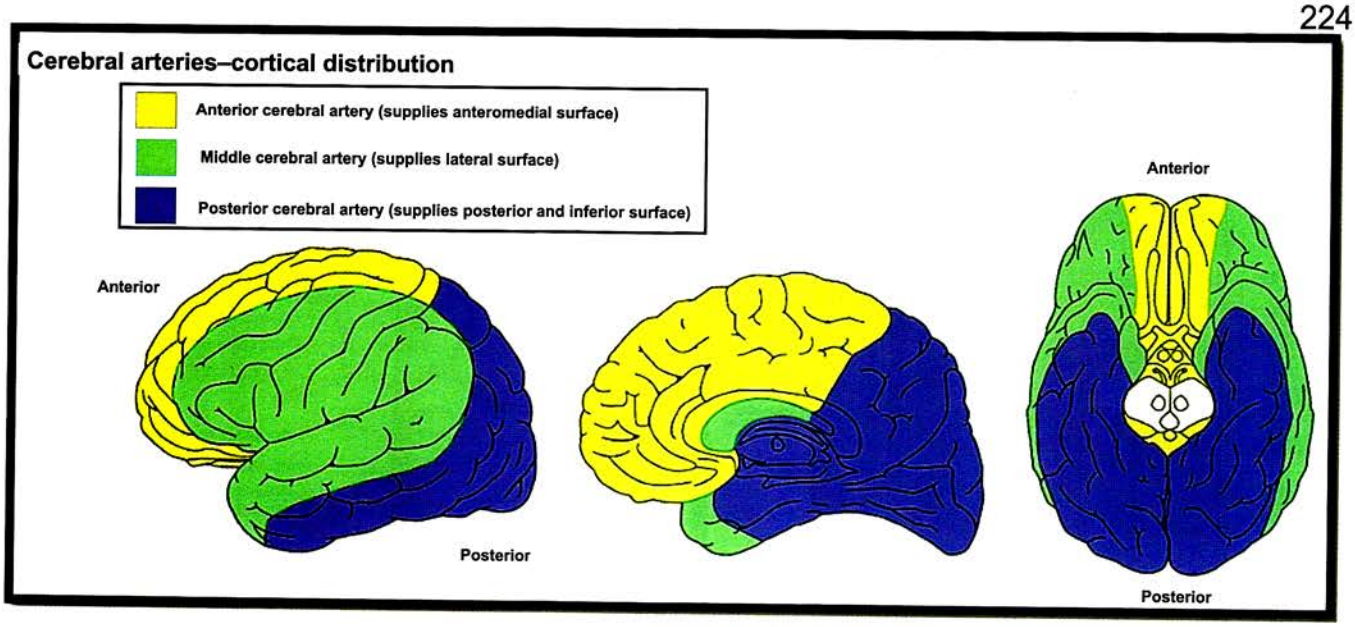
- 2 posterior cerebral arteries
- 2 posterior communicating arteries
- 2 internal carotid arteries
- 2 anterior cerebral arteries
- 1 anterior communicating artery

Berry aneurysm incidence

- → Ant. communicating artery → 40%
- → Post. Communicating artery → 20%







Area no. 4

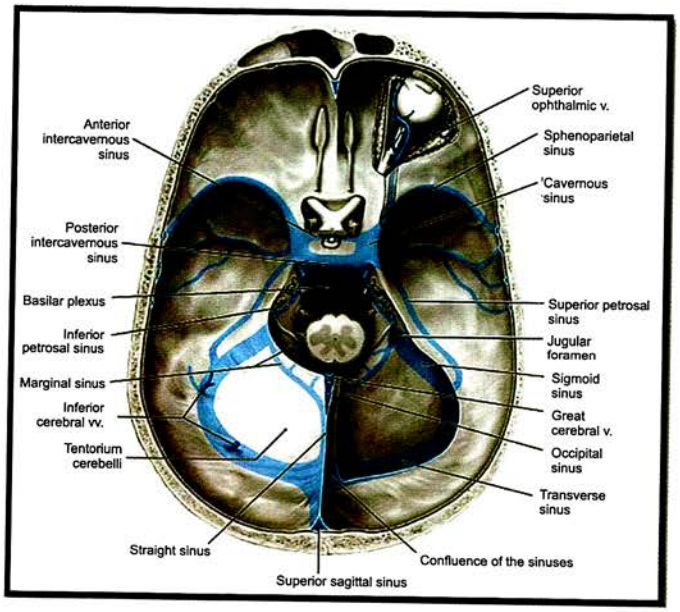
Present in Lateral cerebrum → supplied by MCA
(upper body homunculus)
Medial cerebrum→ supplied by ACA
(lower body homunculus)

Vascular territory	Neurological symptoms	
Anterior cerebral artery	Paralysis of lower limb (with or without hemi-sensory defiict)	Bladder dysfunction
Middle cerebral artery	Hemiparesis (with or without hemisensory deficit) mainly affecting the arm and face (Wernickle-Mann type)	Aphasia
Posterior cerebral artery	Hemisensory losses	Hemianopia

Venous drainage of cranial cavity

Dural venous sinuses

→ Intra dural → B/w double fold of dura-mater



→ Superficial middle cerebral vein drains into cavernous sinus

Cavernous sinus drains into petrosal sinus

Superior petrosal sinus drains into transverse sinus

Inferior petrosal sinus drains into internal jugular vein

→ Straight sinus is deep circulation

→ Straight sinus drains into confluence of sinus

→ Confluence of sinuses drains into transverse sinus

→ transverse sinus drain into sigmoid sinus

→ sigmoid sinus drains into internal jugular vein

Internal cerebral veins are around the brain stem & run behind to join to great cerebral vein of galen.

SoS Tribuitaries (confluence of sinus)

S → straight sinus

O → occipital sinus

S → superior sagittal sinus

Falxcerebri contains

1. Superior sagittal sinus
2. Inferior sagittal sinus
3. Straight sinus at base

Dural venous folds & sinuses

SUPERIOR OPHTHALMIC VEIN
INFERIOR OPHTHALMIC VEIN
} Tributaries

CAVERNOUS SINUS

SUPERIOR PETROSAL SINUS

INFERIOR PETROSAL SINUS

PTERYGOID PLEXUS

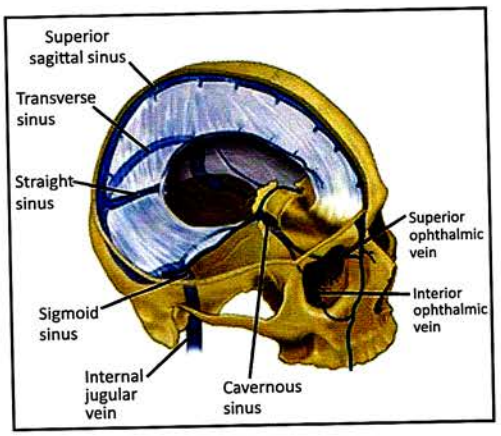
TRANSVERSE SINUS

INTERNAL JUGULAR VEIN

DEEP FACIAL VEIN

FACIAL VEIN

Dangerous area of face



→ infections (staph. Aureus) can access cavernous sinus without proper treatment

Nose (nasal pustule)

↓

Facial vein (mostly)

↓

Angular vein

↓

Superior ophthalmic vein (mostly)
Inferior ophthalmic vein

↓

Cavernous sinus

Deep facial vein

↓

Pterygoid plexus

↓

Cavernous sinus

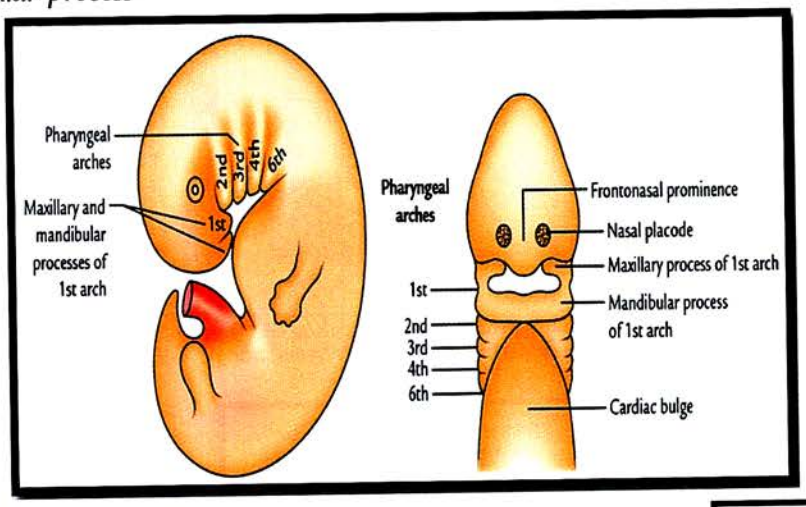
Inferior petrosal vein is the 1st tribuitary of internal jugular vein superior ophthalmic vein has bidirectional flow

→ acts as tributary & draining channel for cavernous sinus

Head & Neck

Pharyngeal Arches

→ 6 U shaped arches
→ Around pharynx
→ Develops from **neural crest cells**
→ 5th arch become **rudimentary in humans**
→ 1st arch has
Upper maxillary process
Lower mandibular process



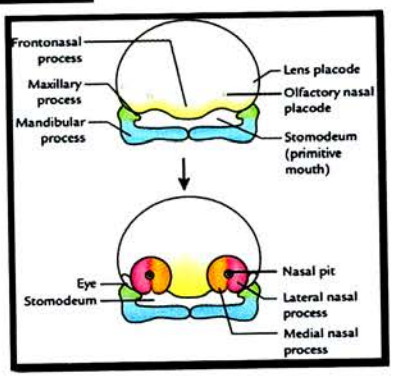
Cleft palate

Cleft palate is classified as **anterior or posterior.**
The anatomical landmark that separates anterior from posterior cleft palate defects is the **incisive foramen.**

→ **Anterior cleft palate** occurs when the **palatine shelves fail to fuse with the primary palate.**

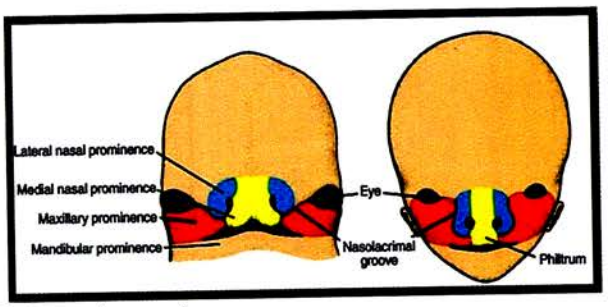
→ **Posterior cleft palate** occurs when the **palatine shelves fail to fuse with each other and with the nasal septum.**

→ **Anteroposterior cleft palate** occurs when there is a combination of both defects.



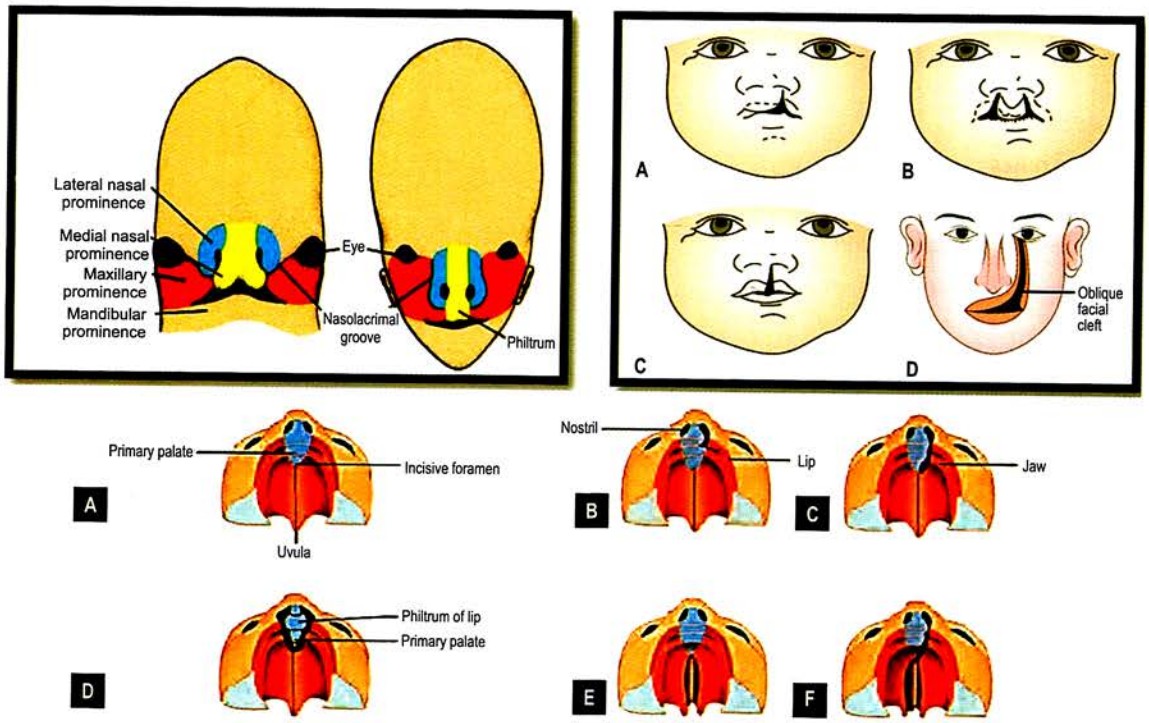
Cleft lip : Cleft lip may occur unilaterally or bilaterally.

→ **Unilateral cleft lip is the most common** congenital malformation of the head and neck.

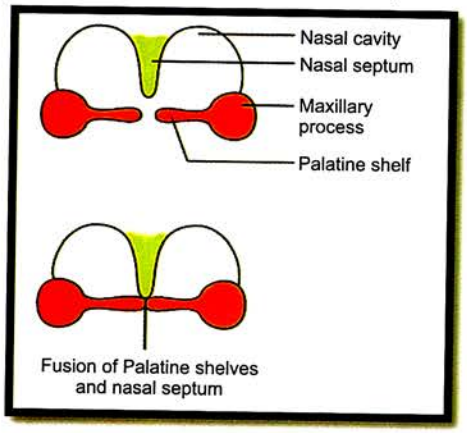


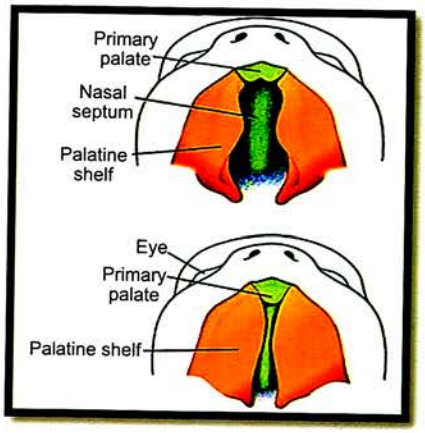
→ It results from the following:

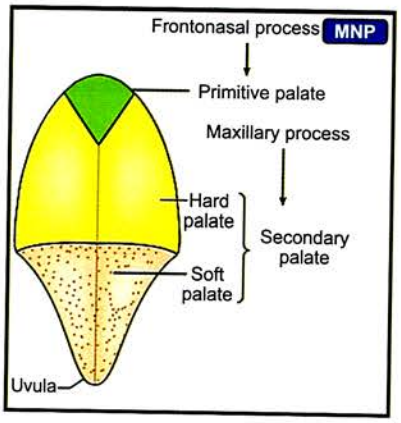
a) **The maxillary prominence fails to fuse with the medial nasal prominence.**
b) **Midline cleft lip (hare lip) is due to non-fusion of the two medial nasal processes in the midline.**

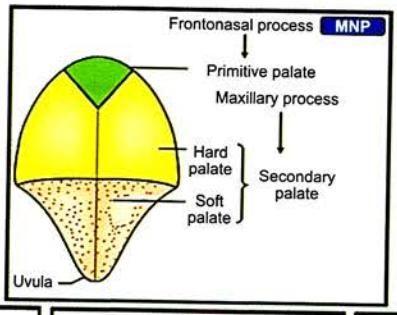


Figs. 106A to F: Ventral vie of the palate, gum, lip, and nose. (A) Normal. (B) Unilateral cleft lip extending into the nose. (C) Unilateral cleft involving the lip and jaw and extending to the incisive foramen. (D) Bilateral cleft involving the lip and jaw. (E) Isolated cleft palate. (F) Cleft palate combined with unilateral anterior cleft lip.

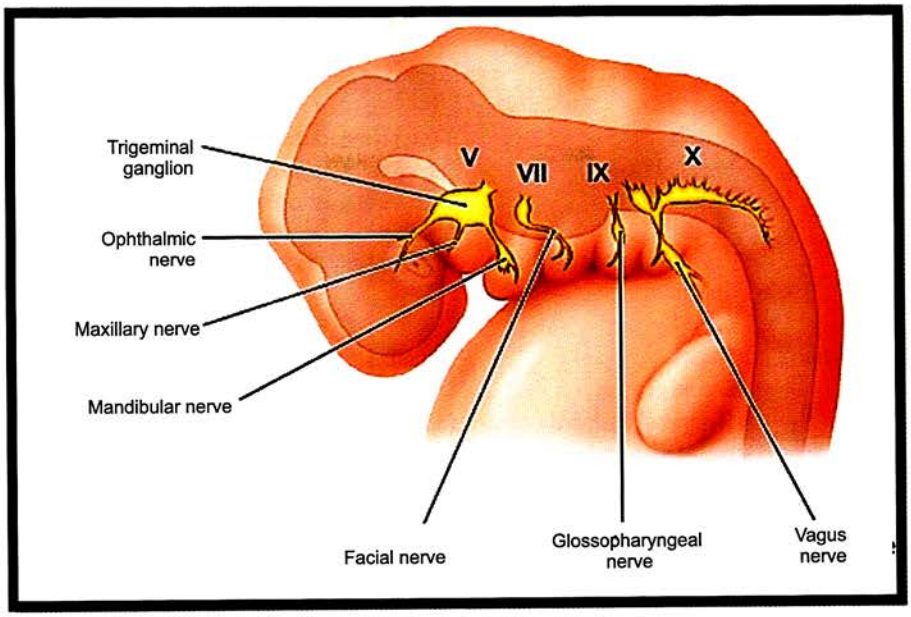








Incomplete cleft palate | Unilateral complete lip and palate | Bilateral complete lip and palate



NCC-Neural Crest Cells derived

→ mandible, hyoid

Para axial mesoderm → Pharyngeal arch muscles. E.g. Muscles of mastication

4th Arch → Thyroid cartilage
Epiglottis cartilage

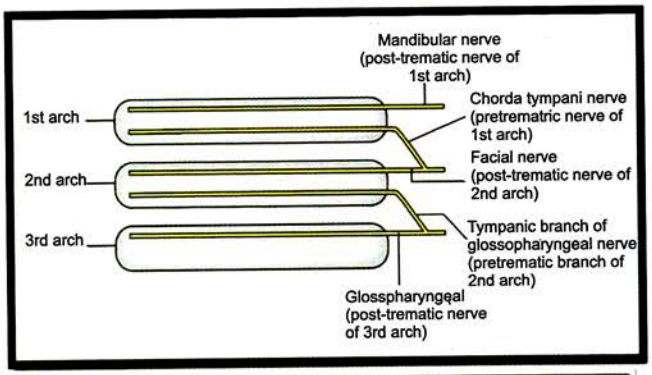
6th arch→ Cricoid
Arytenoid
Corniculate
Cuneiform

Pharyngeal arch nerves

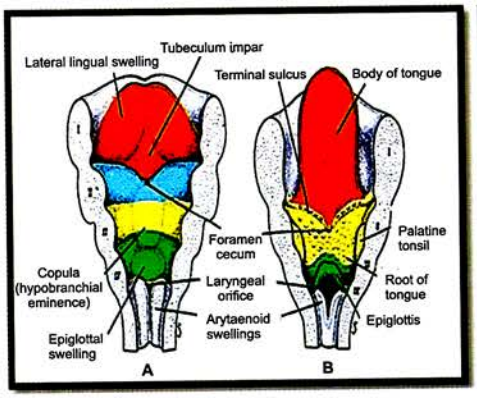
1st Arch → mandibular division of trigeminal nerve

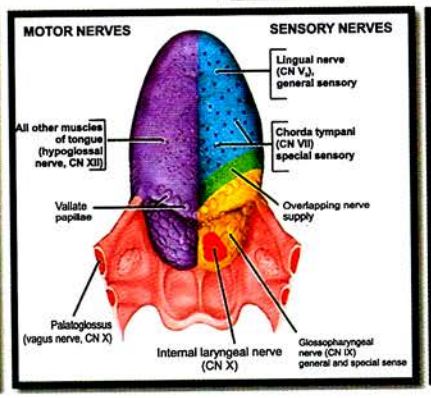
2nd Arch → facial nerve

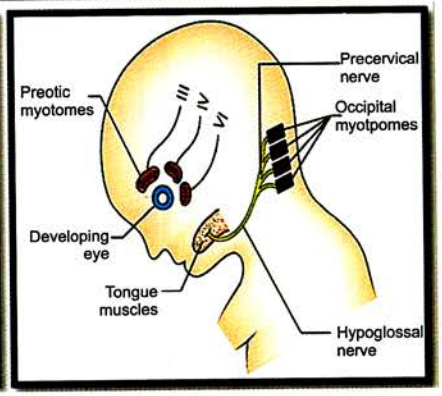
3rd Arch	Nucleus Ambiguus
4th Arch	CN 9
6th Arch	CN 10
	CN 11 (cranial part)



Developing Tongue

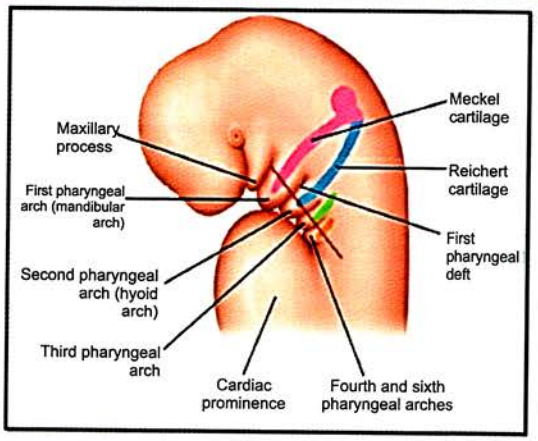


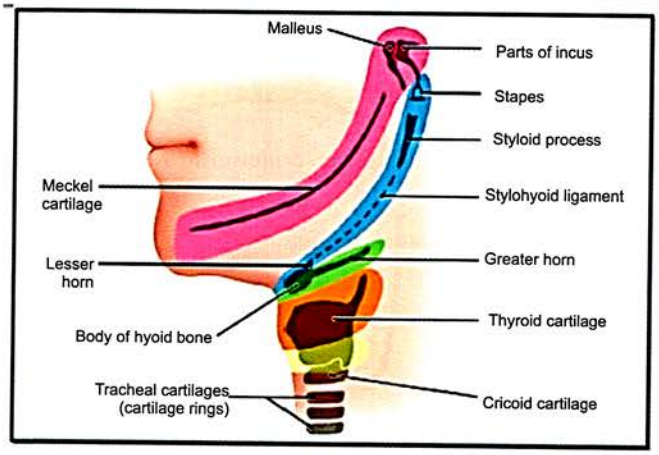


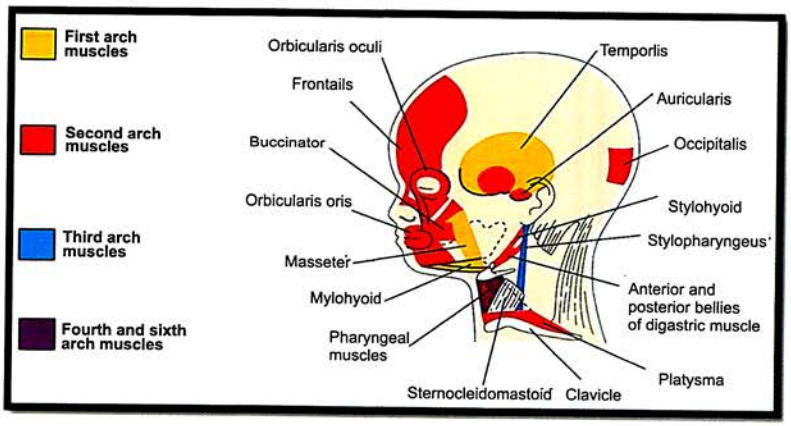


Derivatives of the pharyngeal arches

Arch No.	Nerve	Embryonic cartilage	NCCs/Mesoderm	Mesoderm (Muscles)	Misc	Artery
1.	CNV_3	Quadrate/ Meckel's	Maxilla Mandible (GT) Incus Malleus Anterior ligament of malleus Sphenomandibular liga-ment	Tensor tympani Tensor veli palatini Muscles of mastication Mylohyoid Anterior belly digastric	Anterior 2/3 of tongue	Maxillary (transitory)
2.	CN VII	Reichert's	Stapes Styloid process Stylohyoid ligament Lesser horn and upper part of body of hyoid bone	Stapedius Stylohyoid Facial muscles (incl. Buccinatory/Platysma, auricular, occipitofrontalis) Posterior belly digastric		Stapedial/Hyoid artery (transitory)
3.	CN IX		Greater horn and lower part of body of hyoid	Stylopharyngeus	Posterior 1/3 of tongue	Common caroitd artery Internal carotid artery (first part)
4.	CN X Pharyngeal branch superior laryngeal branch		NCSs: none Thyroid Cartilage Epiglottis	Palate (Levator, etc.) Pharynx Cricothyroid	Root of tongue	Right subclavian artery (proximal part) Arch of aorta (between origins of left common carotid and left subclavian arteries)
6	CN X Recurrent laryngeal branch		NCCs: none Cricoid Arytenoid cartilages	Larynx		Pulmonary arteries D arteriosus







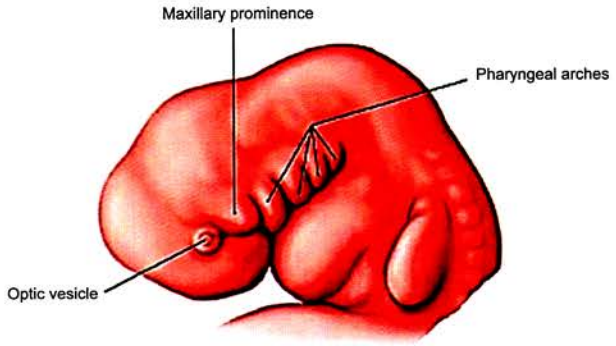
Pre Trematic Nerves

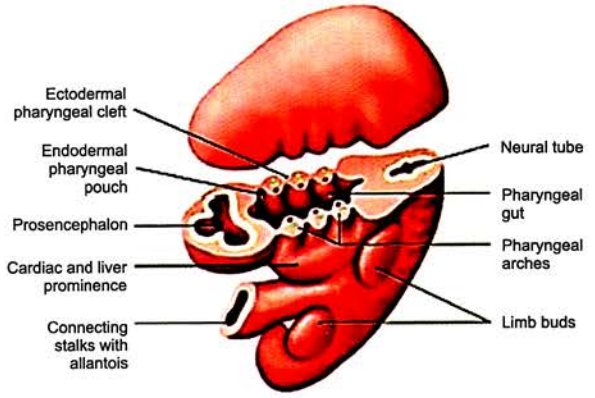
1st Arch → 53 (Mandibular division of trigeminal nerve.)
→ Chorda tympani nerve of facial nerve

2nd Arch → Tympanic branch of glossopharyngeal nerve

Pharyngeal pouches & clefts

Pouches → IN the lateral wall of pharynx inside → **lined by ectoderm**

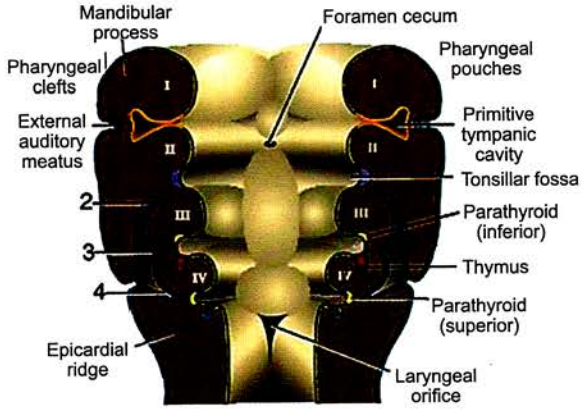


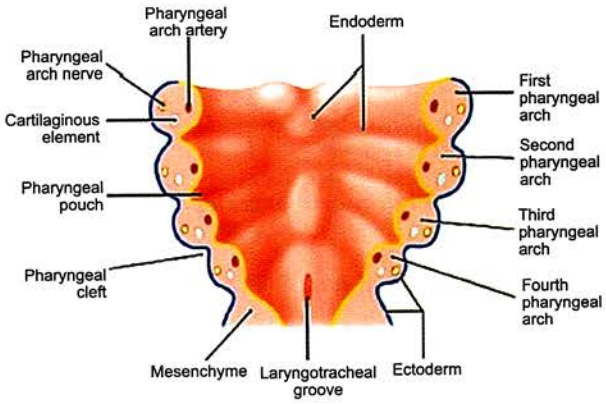


Coronal section

Lateral wall

→ pouches inside lined by **Endoderm** , clefts outside lined by **ectoderm**





Cleft 1 → External auditory meatus → **surface ectoderm**

Cleft 2,3,4 → obliterated
Mesoderm of 2nd arch covered them
→ Cervical sinus (remnant of cleft 2,3,4)
(**Sinus – any blind sac with one opening**)
Opening **disappears** to form cyst (**branchial cyst**)

Pouch 1 → **Middle ear** cavity
Eustachian tube (opens into **nasopharynx**)

Pouch 2 → Forms **endodermal** epithelium for tonsil lines **tonsillar crypt**
Tonsil is derived from **mesoderm (sec)** from NCCs

Pouch 3 → **Ventral → thymus Dorsal → iferior para thyroid**

Digeorge syndrome

→ **pouch 3 & 4** compromised

→ No thymus → ↓ Cell Mediated Immunity → severe bacterial infection

Hypocalcemia (tetany) → causes **cardiac anomalies**

Inferior parathyorid defect ↓ PTH ↓ Ca^{2+}

→ **MC cause of death** → **AP septum anomalies**

Pouch 4 → Superior parathyroids

Pouch5 → Ultimate branchial body (vestigial remnant)

→ **fuse with 4th pouch**

→ receives NCCs & changes to parc

Thyroid development

→ Endodermal

→ at floor of pharynx → **Tongue development**

↓

Foramen caecum

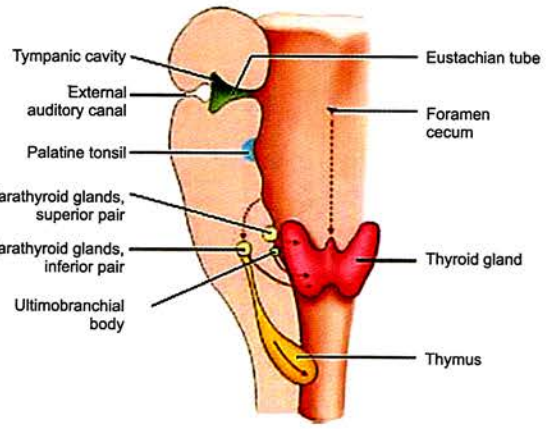
↓

Thyroglossal duct

↓

Thyroid

UBB → NCCs comes here → **parafollicular C cells**



Blood Circulation

Heart

↓

Aortic Sac

↓

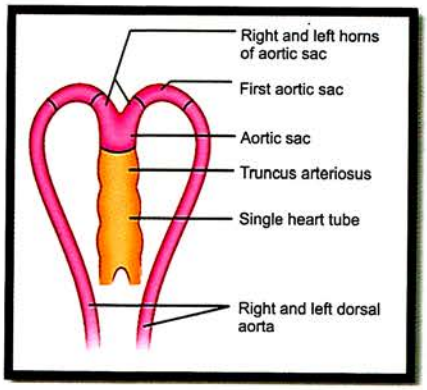
Pharyngeal arteries 1-6

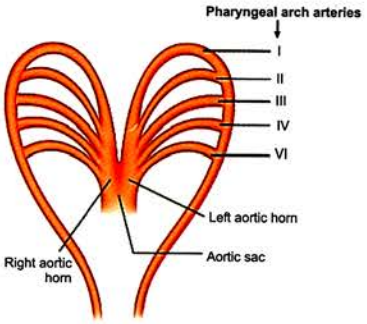
↓

Dorsal aorta (rt&lt)

↓

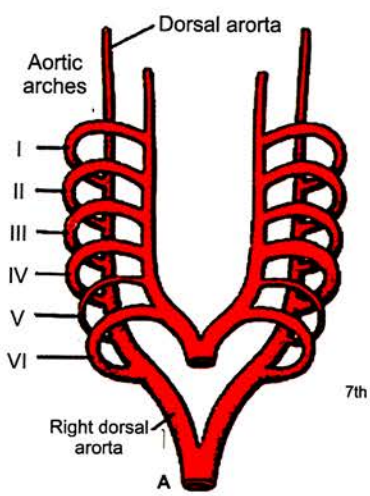
Dorsal aorta fused inferiorly

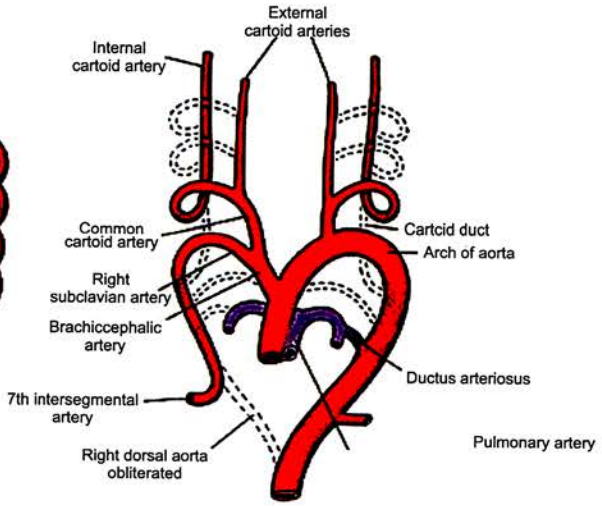




Arches 1,2,5 disappears

Arches 3,4,6 persists





Remnants

- 1st Arch → Maxillary artery (part)
- 2nd Arch → Stapedial artery (part)
- 5th Arch → No remnant

ARCH 3	→	Rt & Lt COMMON CAROTID ARTERIES [portion of] Rt & Lt INTERNAL CAROTID ARTERIES [portion of]
ARCH 4		
Rt. side	→	Rt. SUBCLAVIAN ARTERY [portion of]
Lt side	→	ARCH OF AORTA [part b/w Lt subclavian & Lt com. carotid Ar.]
ARCH 6	→	PULMONARY ARTERY [Rt & Lt] DUCTUS ARTERIOSUS [Left is left, Rt disappears]

External carotid artery → Denovo branch

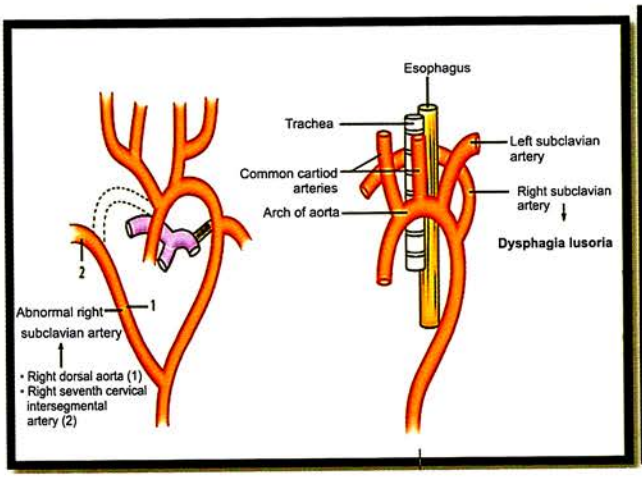
Rt. subclavian artery contributed by → Rt 4th arch
→ Rt dorsal aorta (part of)
→ Intersegmental artery no. 7

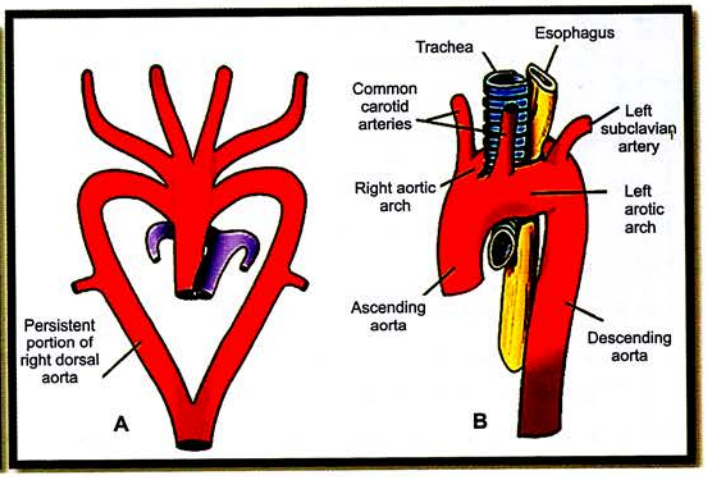
Lt subclavian artery contributed by → Intersegmental artery no. 7

Double Aortic ARCH

→ Persistent distal portion of rt dorsal aorta
→ Difficulty in breathing & swallowing d/t compression by Rt. aortic arch

Embryonic	Adult
Aortic arch arteries	
1	Maxillary artery (portion of)
2	Stapedial artery (portion of)
3	Right and left common carotid arteries (portion of) Right and left internal carotid arteries
4	Right subclavian artery (portion of) Arch of the aorta (portion of)
5	Regresses in humans
6	Right and left pulmonary arteries (portion of) Ductus arteriosus





Trigeminal nerve

Ophthalmic Branch (V_1)

→ supplies skin of **fore head & tip of nose**

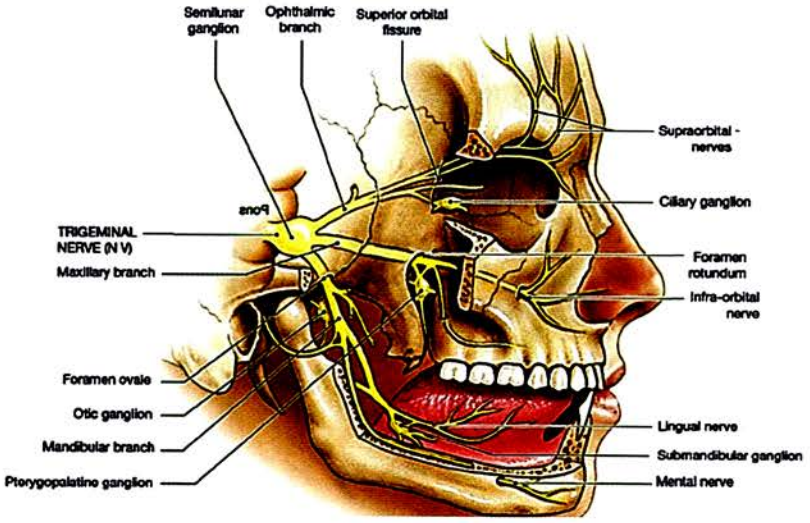
→ In herpes zoster **(vesicles at tip of nose)**

→ **ophthalmic branch** 1% involved

Maxillary branch (V_2)

→ supplies **skin on lower eye lid, upper lip & maxilla bone**

Mandibular branch (V_3) → supplies skin of mandible **except angle of mandible**



Maxillary nerve

→ Passes **foramen rotundum**

→ Pterygopalantine ganglion in pterygopalatine fossa

→ **supplies**

L lacrimal gland

N Nasal gland

P Palatine gland

→ **Functional nerve → facial nerve**

Topographic nerve → maxillary branch of trigeminal nerve

→ passes **inferior orbital fissure** & become inferior orbital nerve & run at floor of orbit

Carries pain of upper teeth **(pain of lower teeth by mandibular nerve)** pain of maxillary sinusitis .

Mandibular nerve (V_3)

→ Supplies **mandible bone, mandibular teeth** (carries lower teeth pain)

→ Passes through foramen ovale & related topographically with **otic ganglion**

→ **Otic ganglion**

→ **Functional nerve** → glossopharyngeal nerve

Topographic nerve → mandibular nerve of trigeminal nerve

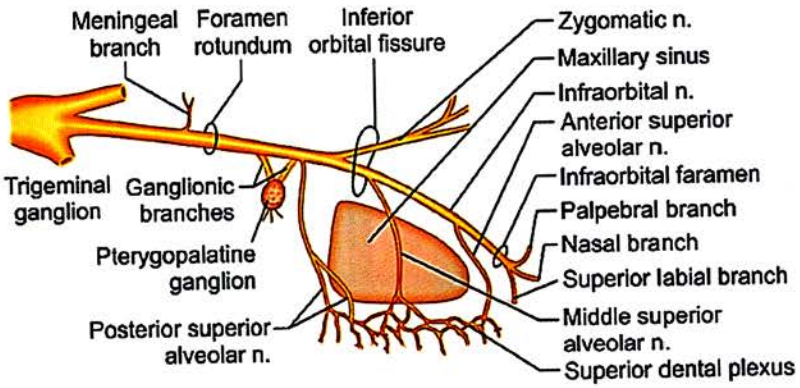
→ **Supplies → parotid salivary gland**

→ Otic ganglion is more medial & deeper to mandibular nerve

→ **Sub mandibular ganglion**

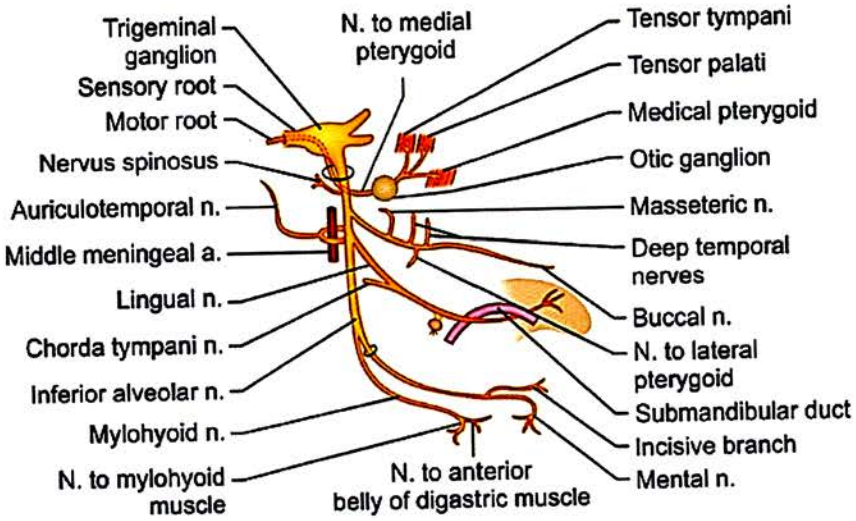
→ supplies submandibular salivary gland
Sublingual salivary gland
→ Functional nerve → facial nerve
Topographical nerve → Lingual branch of mandibular br. Of CN V

Maxillary Nerve



Mandibular nerve (mixed nerve)

→ MIXED → SENSORY [mandible]
MOTOR [muscles of masticat n]



Auriculo-temporal nerve supplies → skin of tongue & temporal skin

Ophthalmic branch

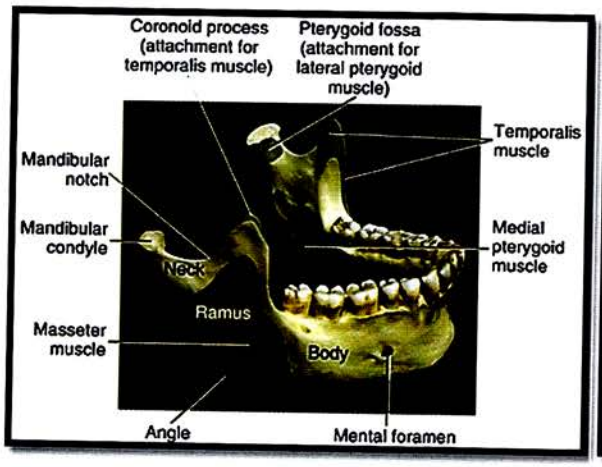
3 sensory branches passes of & enters orbit

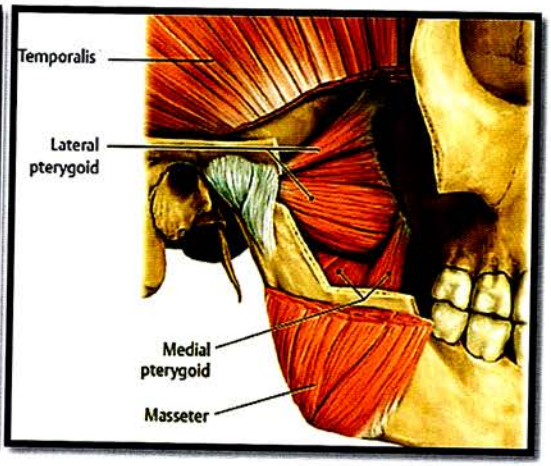
1. Lacrimal nerve → most lateral
2. Frontal nerve → middle
3. Nasociliary nerve → most medial

Ciliary ganglion

1. EDW nucleus sends pre ganglionic fibres.
   Carried by occulomotor nerve (3) (functional nerve) & synapses in ciliary ganglion
2. Post ganglionic fibres carried by trigeminal nerve (Topographic) & supplies
   Ciliaris → ↑ lens convexity (accommodation reflex)
   Sphincter pupillae → miosis (light reflex)

Muscles of mastication





→ Develops from 1st pharyngeal arch
→ Supplied by **mandibular nerve of V**
→ **8 muscles**

3 elevators

M →Massester (by anterior division)
T → Temporalis (by anterior division)
Me →Medial pterygoid (by main trunk)

3 Depressors

Mylo hyoid **(by inferior alveolar nerve)**
Anterior belly of digastric **(by inferior alveolar nerve)**
Lateral pterygoid(chief depressor) **(by mandibular nerve)**
} gravity

2 Tensors

Tensor tympani → ↓ intensity of sound
Tensor palati → tense the palates
Opens the Eustachian tube

Elevators & depressors

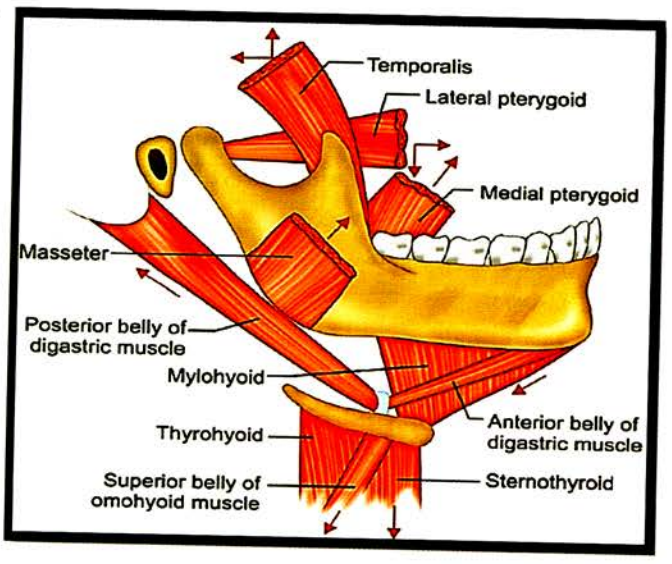
Insertion → mandible

Mandible

Temporo mandibular joint → condylar joint lateral
Pterygoid muscle inserted on pterygoid fossa

Helps in protrusion (chief action) depression
Masseter inserted on ramus & angle of mandible on lateral side
Medial pterygoid inserted on ramus & angle of mandible on medial side

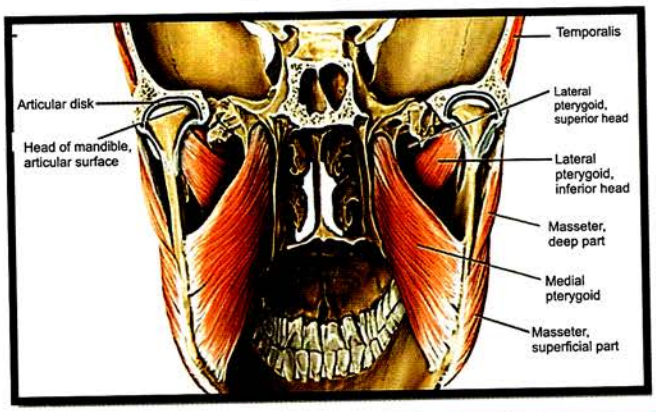
Temporalis inserted into coronoid process
Helps in retraction, elevation
Origin of temporalis → **temporal bone**



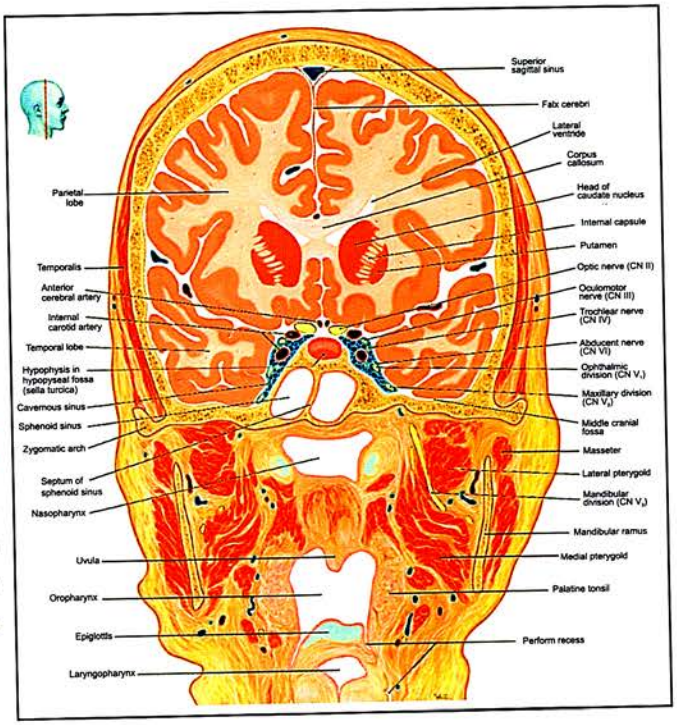
Digastric muscle (Hybrid muscle, dual motor nerve supply)

Anterior belly → Attaches to mandible bone & hyoid bone
→ Develops from 1st **pharyngeal arch**
→ Depressor of mandible
→ **Both mylohyoid & anterior belly** supplied by mandibular N(5_2)

Posterior belly → Attaches to **hyoid bone & mastoid bone** develops from 2nd **pharyngeal arch**
supplied by facial nerve

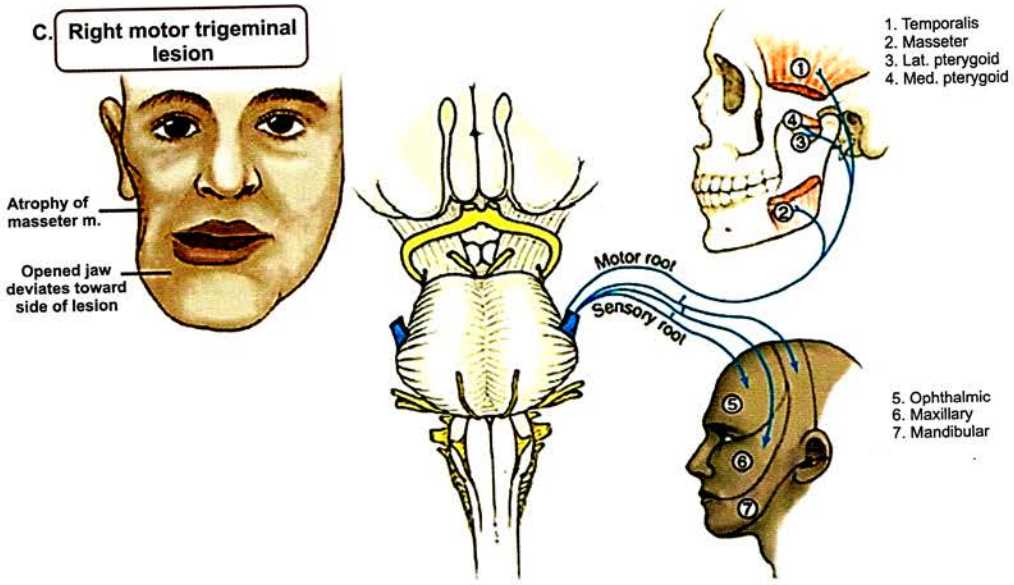


Movements of Mandible	Muscle(s)
Elevation (close mouth)	Temporalis, masseter and medial pterygoid
Depression (open mouth)	Lateral pterygoid, Suprahyoid and infrahyoid muscles
Protrusion (protrude chin)	Lateral pterygoid, masseter and medial pterygoid
Retrusion (retrude chin)	Temporalis and masseter
Lateral movements (grinding and chewing)	Pterygoids of opposite side



Lateral pterygoid actions

A→ Anterior
I → Inferior
M → Medial



Genu of facial nerve

- → contains geniculate ganglion
- → gives greater petrosal nerve which is topographically related with maxillary nerve

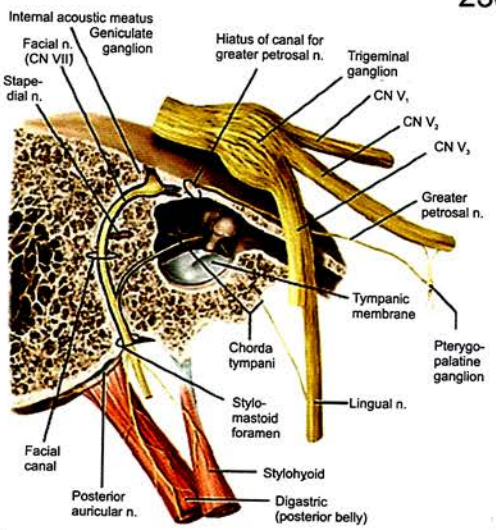
Facial canal

- → present in posterior wall
- → contains facial nerve

Gives 3 branches

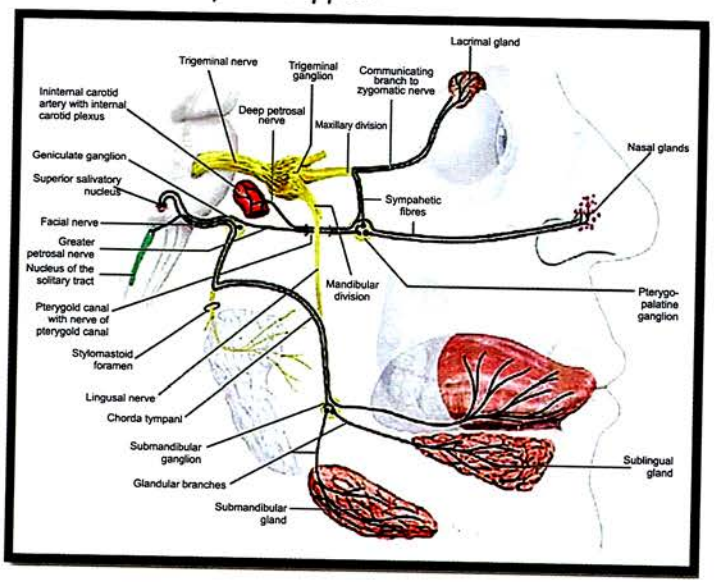
1. Greater petrosal nerve
2. Nerve to stapedius
3. Chorda tympani nerve **(present on Tympanic membrane & related to malleus bone)** joins **with lingual nerve** in infra temporal fossa

Facial nerve exits cranial cavity by passing through stylomastoid foramen



Facial nerve comes from ponto-medullary junction, nuclei are in the pons **supplies**

1. Pterygo-palatini ganglion
2. Sub-mandibular ganglion
3. Lacrimal gland
4. Sub-lingual gland
5. Sub-mandibular gland &
6. Carries taste from ant. 2/3rd of tongue
7. **Supply muscles of facial expression**
   - → Orbicularis oculi
   - → Orbicularis ori
   - → **Zygomaticus major (smile muscle)**
   - → Buccinator



Geniculate ganglion

- → Present in middle ear cavity
- → Have taste sensory neurons
- → Present in taste pathway

Superior Salivatory Nucleus Controls

- → Lacrimal Gland Controlled By **Pterygopalatine ganglion**
- → Nasal Gland Controlled By **Pterygopalatine ganglion**
- → Palatine Gland Controlled By **Pterygopalatine ganglion**
- → Sublingual Gland
- → Sub-Mandibular Gland

Sub Mandibular ganglion

- → Greater Petrosal Nerve controls pterygopalatine ganglion
- → Chorda tympani nerve control sublingual and sub-mandibular glands

Functional nerve : Greater Petrosal nerve,Chorda tympani nerve

Topographic nerve : Trigeminal nerve

Lingual nerve of mandibular nerve joins and chorda tympani nerve in infra-temporal fossa.

➔ Deep petrosal nerve of T1 sympathetic plexus **joins with greater petrosal** nerve (para-sympathetic nerve) **from vidian nerve** of pterygoid canal

➔ Vasomotor rhinitis with intractable rhinorhhea **(Rx by Vidianectomy)**

Facial nerve **exits canial cavity** passing passing **stylomastoid foramen** and passes **through parotid gland** (do not supply) and supplies muscles of facial expression.

Bell's palsy

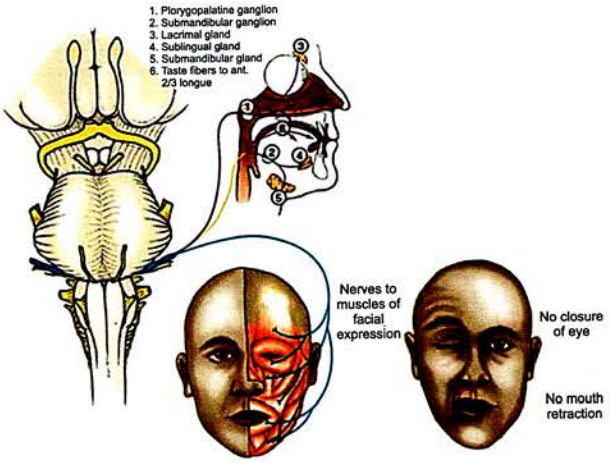
→ Failure to close eye.

→ Can't smile, collection of food

→ Dribbling of saliva

→ **Branches :**

Ant 2/3 of tongue taste carried by chorda tympani nerve towards facial nerve towards tip of nucleus tractus solitarius.



Crocodile tear syndrome

→ Viral exposure / Bell's palsy

→ Lacrimatory nucleus (part of superior salivatory nucleus) → control lacrimal gland

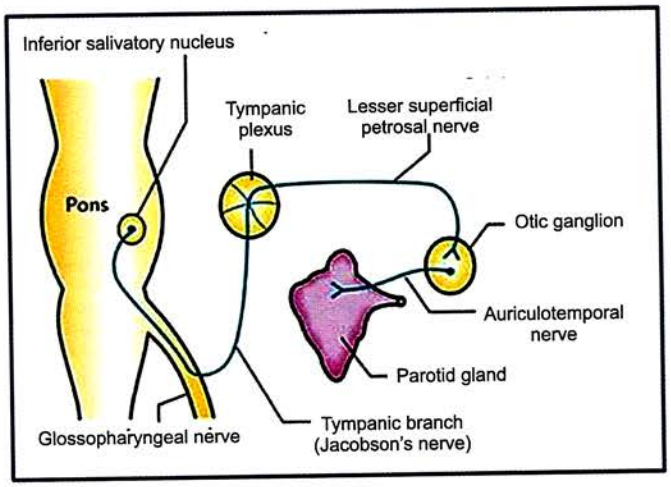
→ Facial nerve (salivary) fibres regenerating

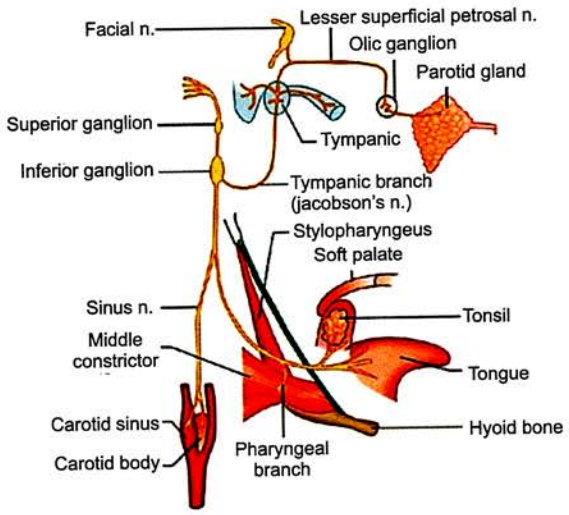
Only directed to salivary gland

Other to misdirected lacrimal gland

While taking food, **tears comes along with saliva**

Glossopharyangeal nerve





→ CN 9 comes from medulla oblongata **behind the olive**

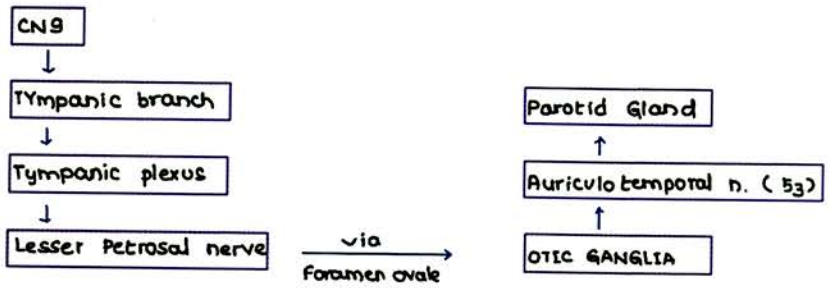
→ **supplies**

1. Carotid body & sinus

2. Posterior 1/3rd of tongue
3. Tonsil
4. Stylopharyngeus

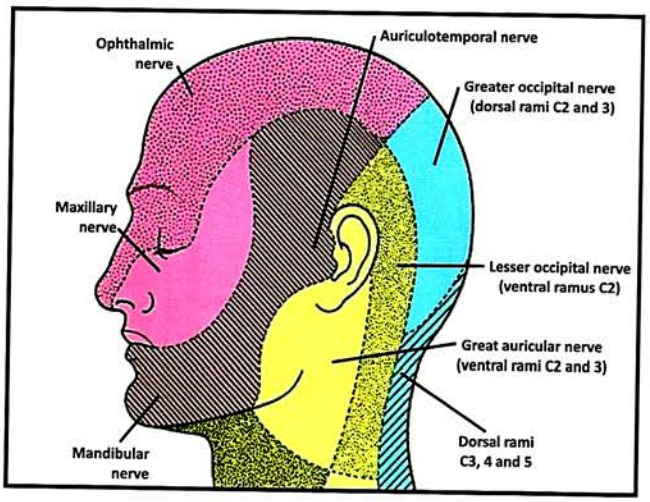
} referred otalgia occurs in these pathology

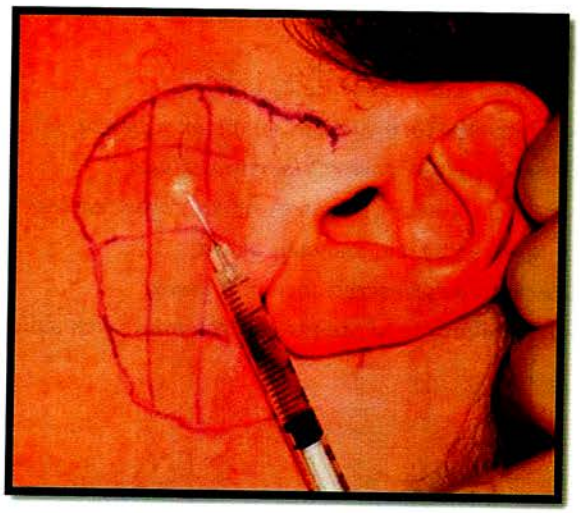
Parotid pathway



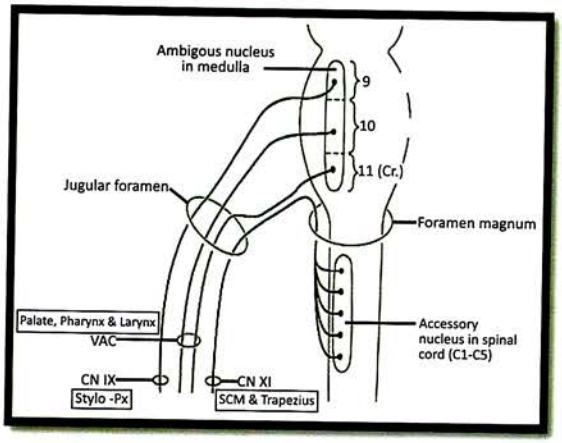
Frey's syndrome /Auricular temporal nerve syndrome

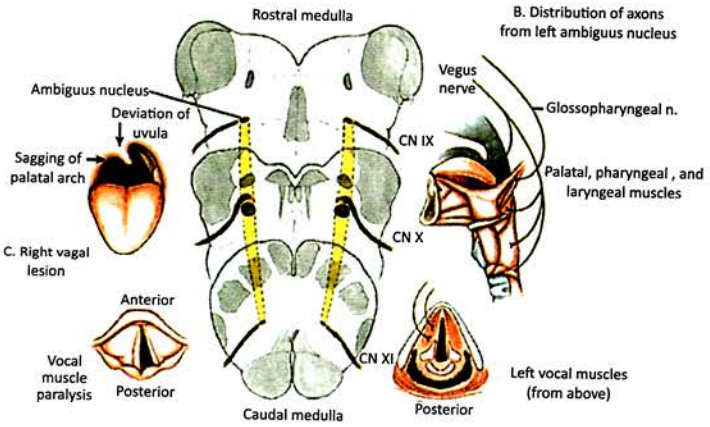
→ d/t injury to Auriculotemporal nerve during parotidectomy
→ Gustatory sweating occurs while taking food





Vagus Accessory complex





→ Vagus nerve carries (vehicle) axons of cranial accessory nerve but do not supply muscles of palate, pharynx, larynx

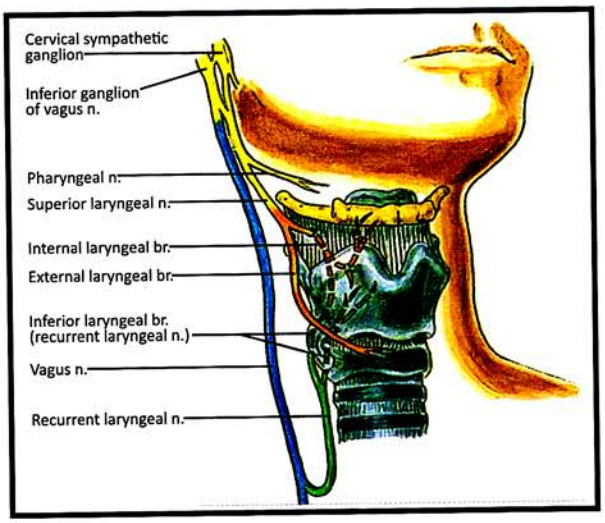
➔ Cranial accessory nerve supplies muscles of palate,pharynx,larynx except

1. Stylopharynegus supplied by CN IX
2. Tensor Palati Supplied by v3

All the muscles of tongue are supplied by hypoglossal nerve except palatoglossus (supplied by cranial accessory nerve)

ARCH	NERVES	CONTROLS
III	CN 9	Stylo Pharyngeus
IV	Superior laryngeal nerve	muscles of Palate EXCEPT Tensor palati
		muscles of Pharynx EXCEPT Stylopharyngeus
		cricothyroid (muscle of larynx, tensor of vocal cord)
VI	Recurrent laryngeal Nerve	muscles OF Larynx EXCEPT Cricothyroid

Nucleus ambiguus
9
10
11 cranial part
} controls muscles of speech & swallowing



Larynx

All larynx muscles supplied by recurrent laryngeal nerve. except cricothyroid

Larynx

→ 3 unpaired midline cartilages

1). Epiglottis
2). Thyroid (largest)
3). Cricoid (ring shaped)

→ 3 paired cartilages

1). Arytenoid
2). Corniculate
3). Cunieform

Elastic cartilages
Epiglottis
Tip of arytenoid
Cunieform
Corniculate

Hyaline cartilages
1). thyroid
2). crocoid
3). most of arytenoid

Cartilage seen posteriorly

1. Cricoid
2. Arytenoid
3. Corniculate
4. Cunieform

Larynx muscles

Cricothyroid

→ Tensor of vocal cord

→ ↑ pitch of voice

Posterior crico arytenoid

→ Most posterior muscle of larynx

→ Safety muscle → only abductor of vocal cord

Thyroarytenoid

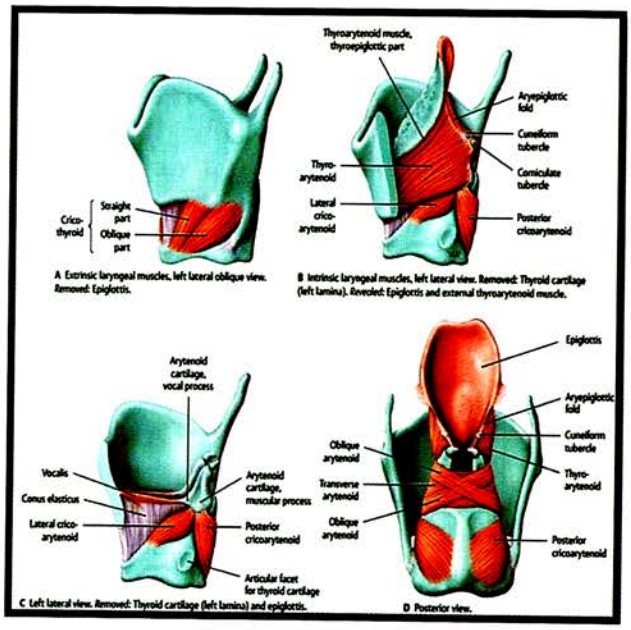
→ Comes from thyroid cartilage anterior to arytenoids posterior

→ **Vocalis → inner part of thyroarytenoid**

→ **Tensor of VC → anteriorly**

→ **Relaxer of VC → posteriorly**

Lateral cricoarytenoid → Adductor of vocal cord



Anterior most cartilage → Thyroid

Ring shaped cartilage → Cricoid

Adductor of VC→ Arytenoid

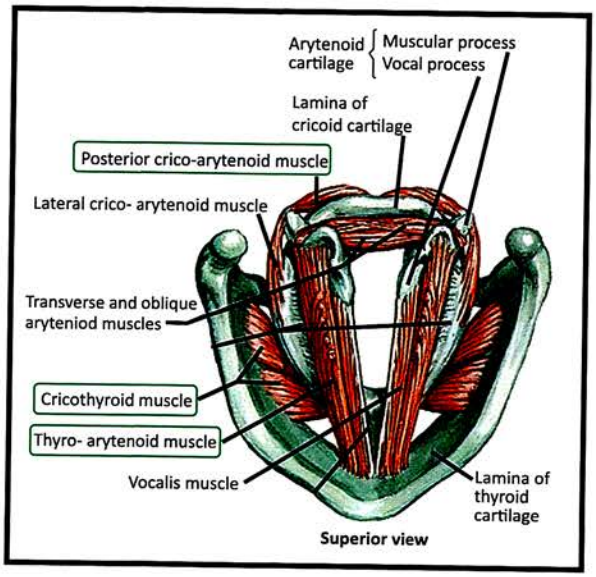
B/L paralysis of post.cricoarytenoid

→ VC in cadveric position

→ **Difficulty in breathing**

→ May require tracheostomy

→ **During general anesthesia, endotracheal intubation should be done**



Digastric Triangle

→ **Digastric muscle**

→ **Anterior belly**

Depressor of mandible

Origin → mandible

Insertion → hyoid

→ **Posterior belly**

Attaches to hyoid & mastoid

→ Bounded by → AB & PB of digastric

Base → mandible

Floor → mylohyoid hyoglossus (depressor of tongue)

Supplied by CN XII

CN XII → came out of hypoglossal canal enter carotid triangle & goes to digastric supplies hypoglossus

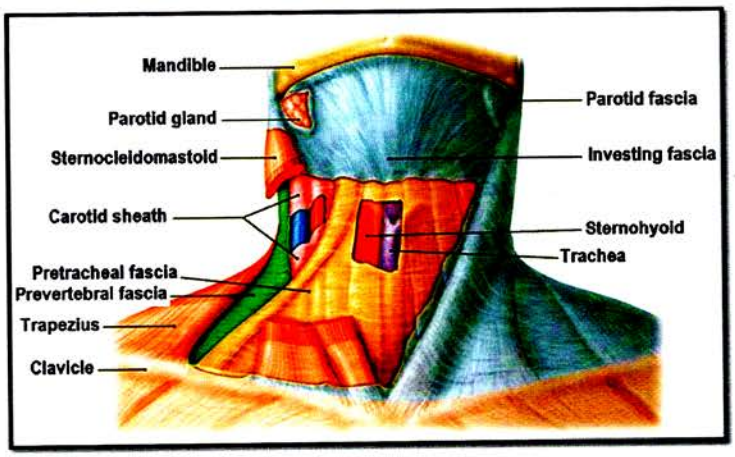
Neck,Facia and spaces

Cervical fascia

Deep cervical fascia

1. Investing fascia (most superficial)
2. Pre tracheal fascia
3. Pre vertebral fascia (at floor of post. triangle)

All 3 fascia contributes to carotid sheath



Investing fascia

→ Forms roof of post. triangle

→ Bounded by

SCM (anterior)

Trapezius (posterior)

→ Split & enclose SCM & trapezius and **goes all around the neck circumferentially**

Pre vertebral fasica

→ Forms floor of post. triangle & covers **scalenus medius**

Pre tracheal fascia

→ goes behind pharynx & oesophagus → circumferential → **buccopharyngeal fascia**

→ has multiple layers

→ **encloses trachea & oesophagus**

Ant. neck muscles

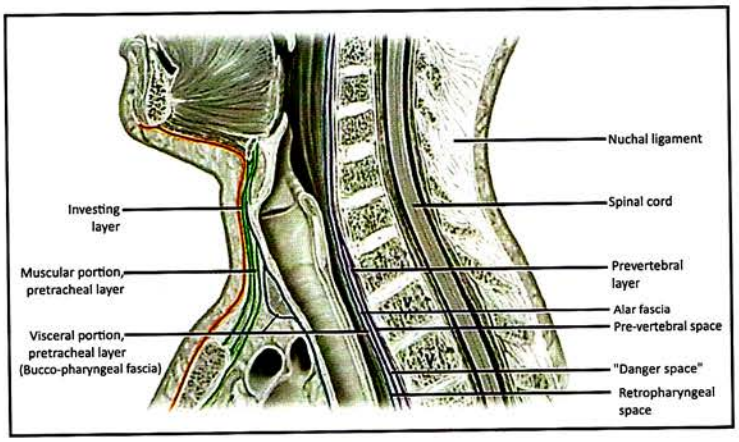
Thyroid gland

→ carotid sheath contributed by

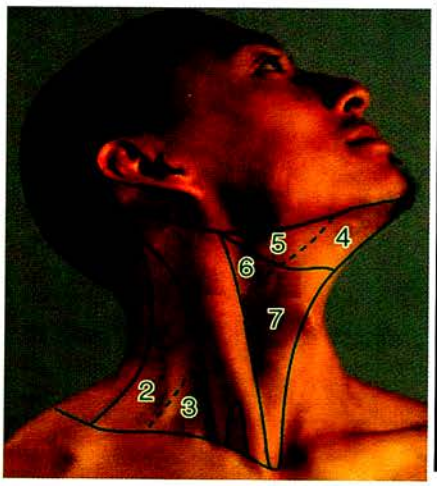
Pre vertebral (posterior)

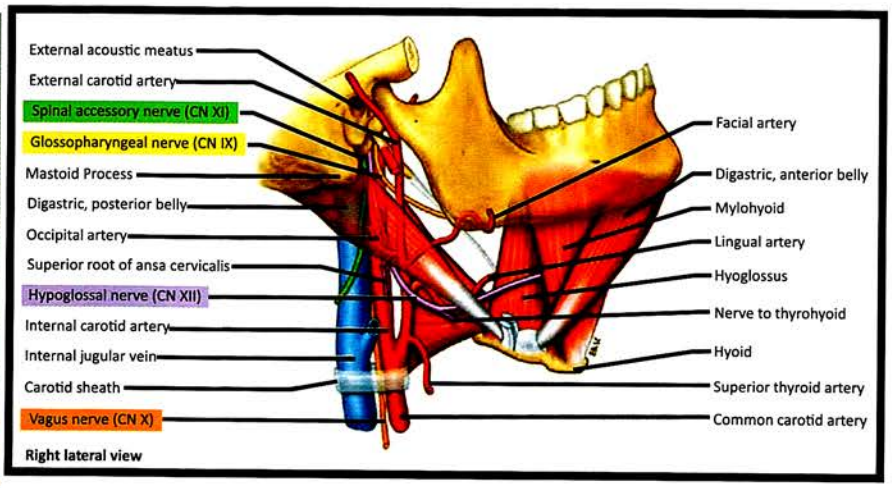
Pre tracheal (anterior)

Investing fascia (lateral)



Carotid triangle

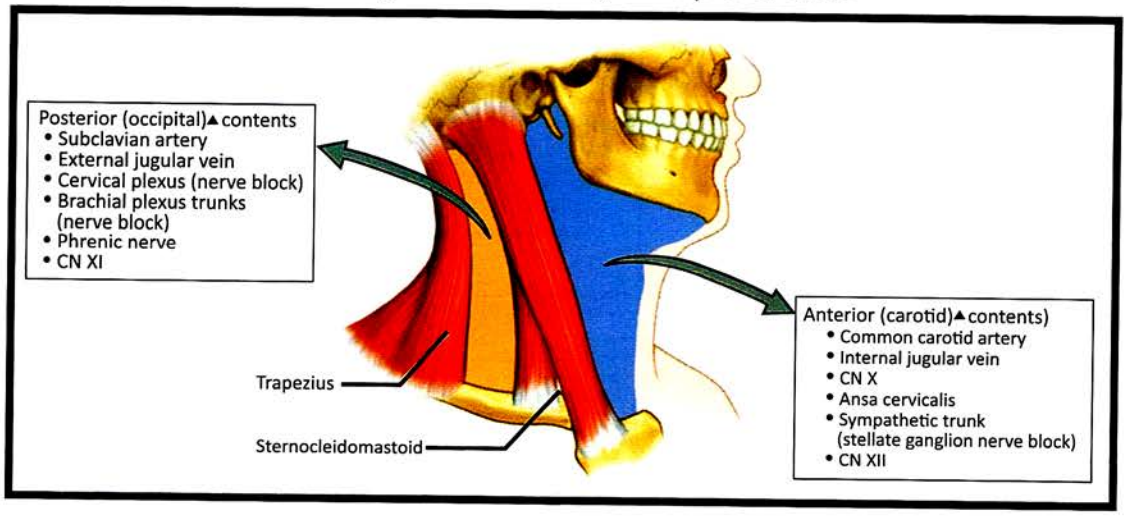




- → Common carotid artery bifurcates into 2 branches
- → CCA followed by Int. jugular vein outside
- → **Bounded by**
  Superior belly of omohyoid
  Posterior belly of digastric
  Sternomastoid

Carotid sheath

- → covers Int. jugular vein laterally, CCA & ICA medially & **vagus nerve between & behind the vessels**
  External carotid artery present outside the sheath
- → Ansacervical is embedded in anterior wall
- → Sympathetic chain present behind carotid sheath
- → Stellate ganglion block can be given here for **Raynaud's phenomenon**



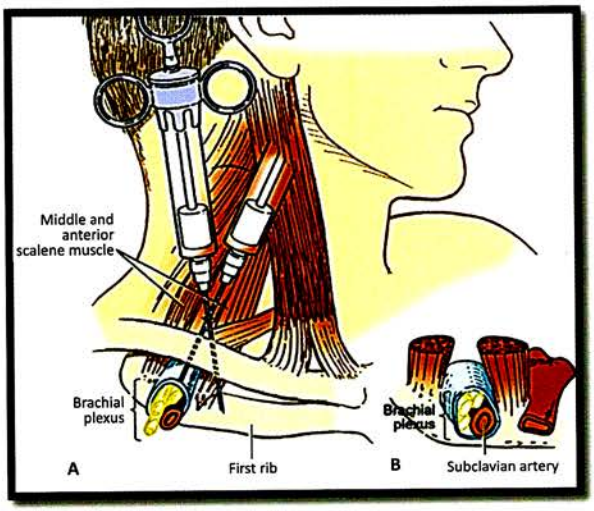
Phrenic nerve

→ don't block (risk of diaphragmatic paralysis)

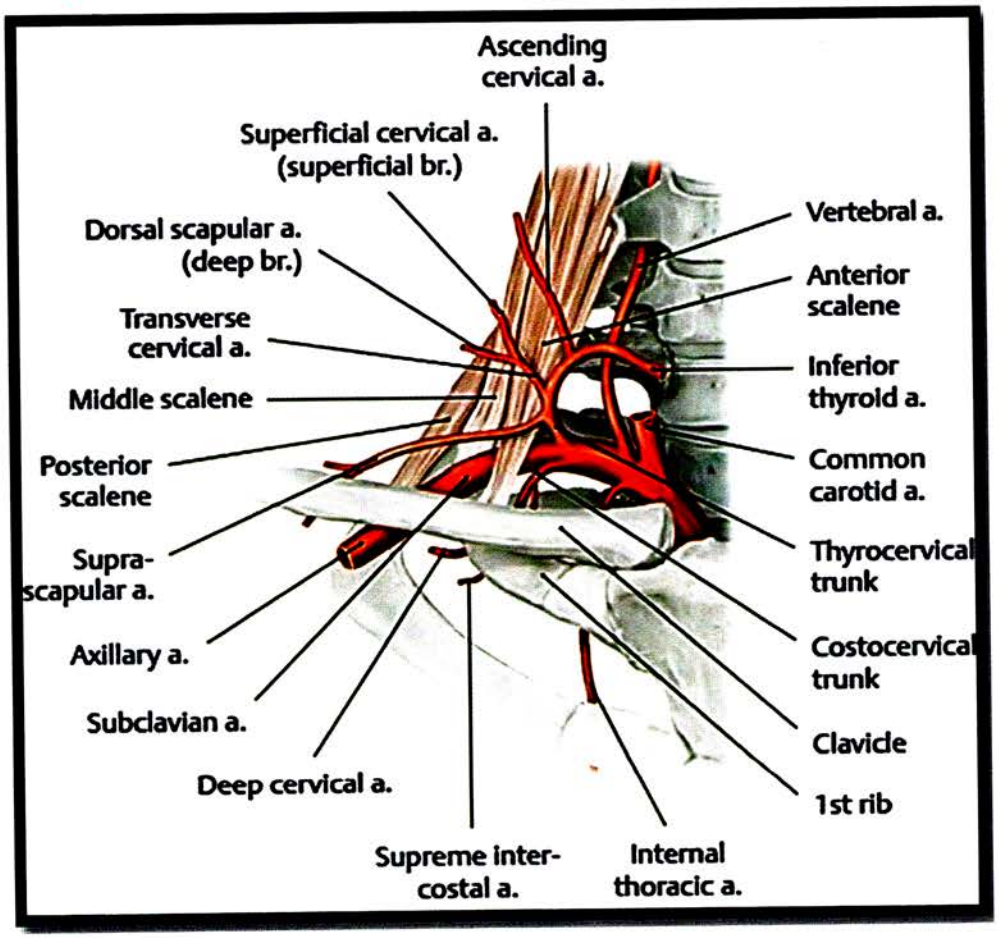
Subclavian artery (3rd part) block

→ runs on superior surface of 1st rib

→ lateral to scalenus anterior & SCM pressure given by thumb

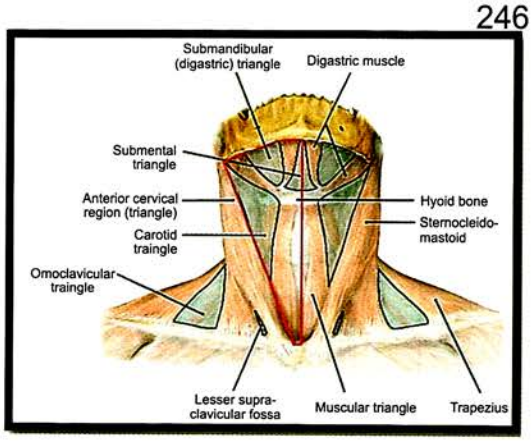


Sub-clavian artery



Sternocleidomastoid

origin→ sternum, clavicle
Insertion→ mastoid
boundary line b/w ant & post. Triangles

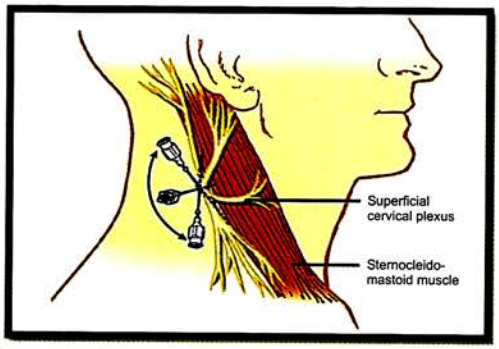


Mylohyoid muscle

→ Coming from mandible to hyoid bone
→ Present at the floor of mouth (floor of DG triangle)
→ **Depressor of mandible** along with AB or digastric)

Sub mental triangle

Base → hyoid bone
Ant & post. belly of digastric on either side



Thyroid gland

→ Covered by strap muscle (stemohyoid)
→ Present in ant. Muscular triangle

Subclavian Triangle

→ 3rd part of subclavian artery can be blocked here lateral to scalenus ant.

Stellate Ganglion Block

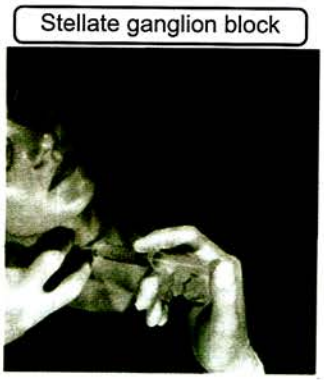
Indications

Sympathetic over Activity

1. Raynaud's phenomenon **(impending gangrene)**
2. Hyperhidrosis

Procedure

Stellate ganglion is identified by Us probe behind carotid sheath & inject agent

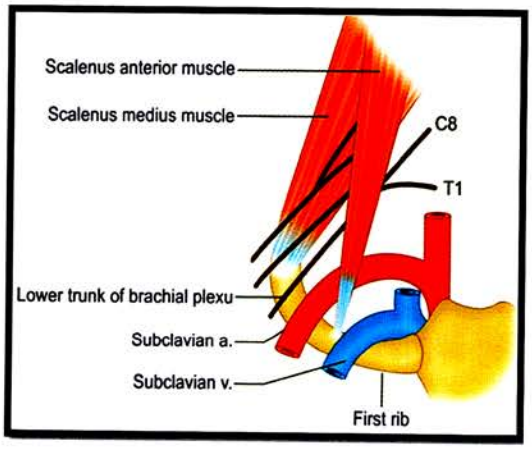


Posterior (occipital) Triangle

→ Brachial plexus trunks
→ subclavian artery
Brachial plexus block & subclavian artery 3rd part block given in subclavian
→ **Cervical plexus (nerve block)**
(at mid point of SCM)

1. Greater auricular nerve
2. Lesser occipital nerve
3. Transverse nerve of neck
4. Supra clavicular neck

→ spinal accessory nerve (CN XI)
→ supplies SCM & Trapezius
→ IN latrogenic injury, **Trapezius is paralyzed** (difficulty in shrugging of shoulder)
(in nerve injury, distal area is involved)
→ External jugular vein



Deep structures to scalp

1. Skull bone
2. Dura mater (opaque)
3. **Arachnoid mater (transparent)**
4. Sub arachnoid space
5. Pia mater covering brain

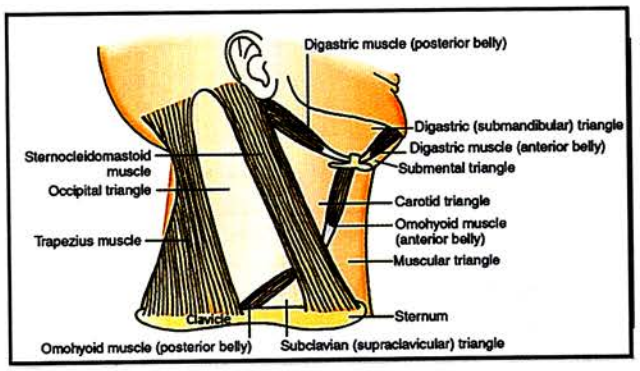
Emissary veins → Intra cranial & extra cranial connections

Scalp bleeding is profuse → vessels are adherent to dense fibres
Diploe → skull (flat bone) with bone marrow

Neck triangles

Sternocleido mastoid

→ boundary line b/w ant & post. triangles
→ **origin → sternum, clavicle**
Insertion → mastoid



Posterior triangles

→ Pre vertebral fascia covers the floor of posterior triangle covers muscles extends as axillary sheath into axilla

→ **Boundaries**

→ **Anteriorly** → SCM
→ **Posteriorly** → Trapezius
→ **Base** → middle 1/3rd of clavicle
→ **inferior belly of omohyoid divides posterior into 2 parts**
1 **occipital** triangle (larger)
2 **subclavian** triangle (smaller)
→ **brachial plexus block given in subclavian triangle for multiple fracture pain**
- 3rd part of subclavian artery blocked here

Anterior triangles

1. **Carotid triangle** → (bounded by sup. Belly of omohyoid) common carotid artery bifurcation occurs here
2. **Digastric triangle** → bounded by digastric base → **mandible**
3. **Muscular triangle** → **Strap muscles (anterior neck muscles)** → sternohyoid thyroid gland covered by strap muscles
4. **Sub mental triangle** → Midline triangle under **mentum of mandible**
→ Boundaries – anterior belly of digastric on both sides ,base → **hyoid bone**
→ **Tip of tongue drains into submental LN** submental LN can drain directly to lower deep Cx or submandibular LN

Outer circle

→ Sub mental lymph node
→ Sub mandibular LN
→ Pre auricular LN
→ Post auricular LN
→ Occipital LN

Cervical lymph nodes

SUPERFICIAL	DEEP
Submental	Retropharyngeal
Submandibular	Jugulo digastric
Preotic | pre auricular	Jugulo-omohyoid
Parotid	
Postotic	
occipital	

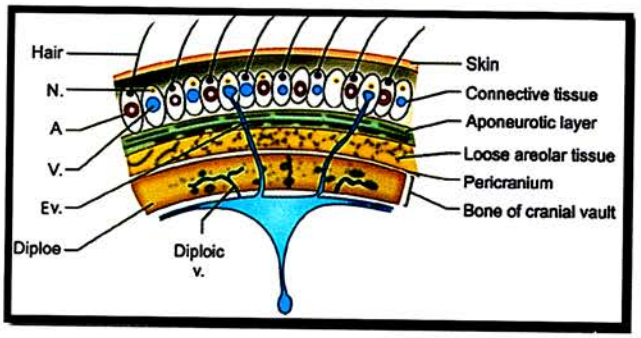
Deep lymphatics

Upper deep cervical → jugulo-digastric LN → drains tonsils
Lower deep cervical → jugulo-omohyoid LN → drains tongue

INNER WALDEYER'S RING		OUTER WALDEYER'S RING
Pharyngeal Tonsils	→	Retropharyngeal LN
Palatine Tonsil Tubal Tonsil	}	Jugulo digastric LN
Palatine Tonsil	→	Other upper Deep cervical LN
Lingual Tonsil	→	Submental & Submandibular LN

Scalp

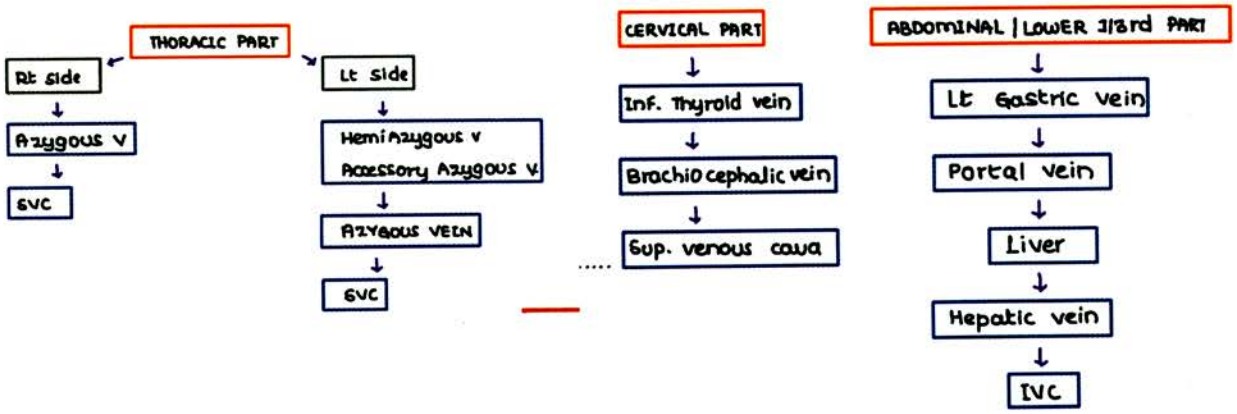
S → Skin (True Scalp)
C → Connective tissue (dense) (True Scalp)
A → Aponeurosis (occipitofrontalis) (True Scalp)
L → Loose connective tissue
P → Pericranium /periosteum



Surgical plane (loose connective tissue)

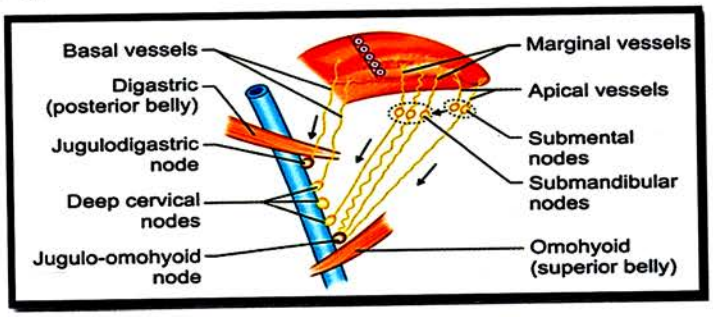
→ Present below true scalp
→ Tissue expanders can be inserted here for surgical grafting
→ Danger area of scalp
- blood & pus accumulate here
- can spread infections into dural
Venous sinuses → meningitis → thrombosis

Aponeurosis → flat tendon of occipitofrontalis



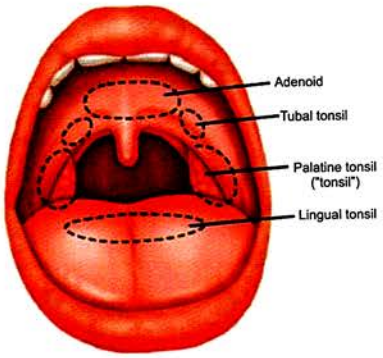
Tongue lymphatic drainage

Tip → sub mental LN → lower deep Cx LN (jugulo- omohyoid)
Middle portion → sub mandibular LN → lower deep Cx LN (jugulo- omohyoid)
Root → upper deep cervical LN (jugulo digastric LN)
Some submental LN drains into sub mandibular LN
Midline of tongue → has bilateral drainage (crossing of lymphatics)
Lateral tongue → drained by I/L LN
Root of tongue → drained has B/L drainage
Tumor on lateral side → I/L LN enlarged
Tumor on midline /root → B/L LN enlarged



Lymphatic drainage around pharynx

Malt → WALDEYER's → inner ring & outer ring
Inner Waldeyer's ring / Waldeyer's ring



Tonsils

→ lingual tonsil
→ palatine tonsil (tonsil)
→ pharyngeal tonsils / adenoid
→ tubal tonsil

Inner most circle (MALT)

- present at entry point of tube
  - Respiratory tube
  - Gut tube
  - Tonsils

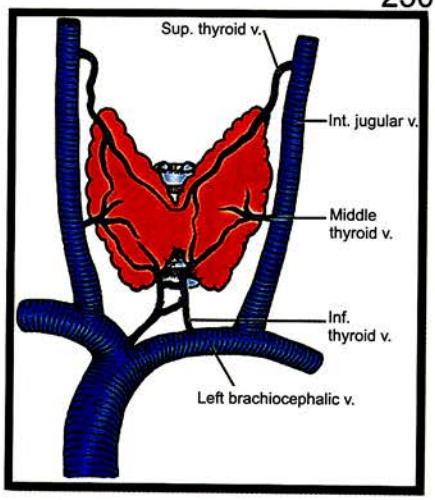
Inner Circle

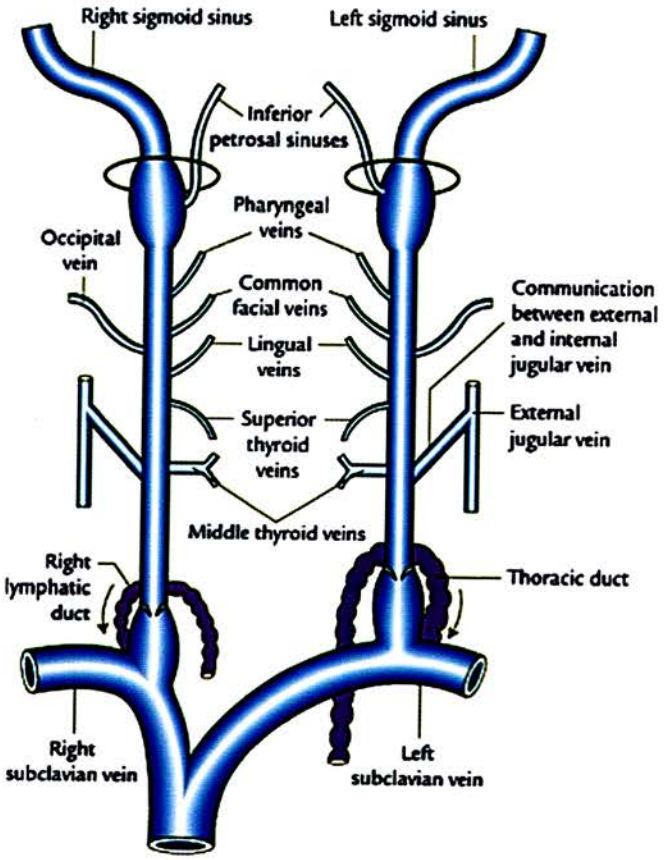
- Para tracheal
- Pre tracheal
- Para pharyngeal

Thyroid gland venous drainage

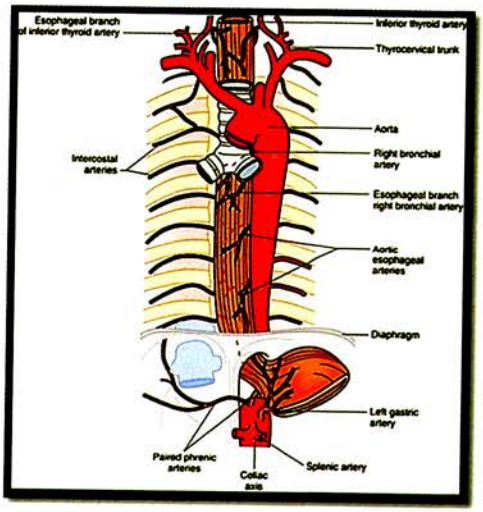
1. **Superior thyroid vein** drains into internal jugular vein
2. **Middle** drains into internal jugular vein
3. **Inferior** → drains in brachiocephalic veins → SVC

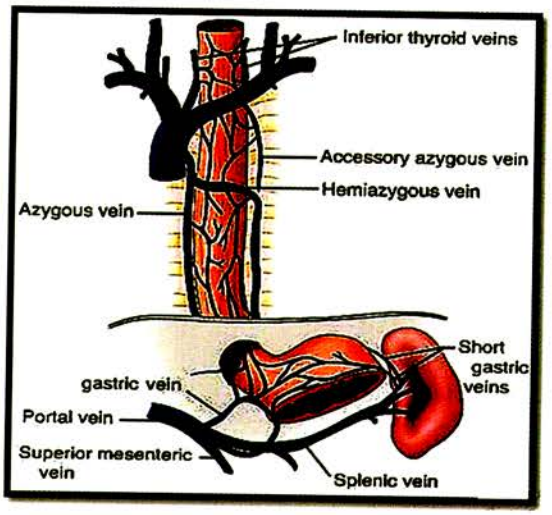
   During **emergency tracheostomy**, the veins prone to injury are
   → **Inferior thyroid vein (present near mid line)**
   → **left brachiocephalic vein crosses midline to enter SVC**





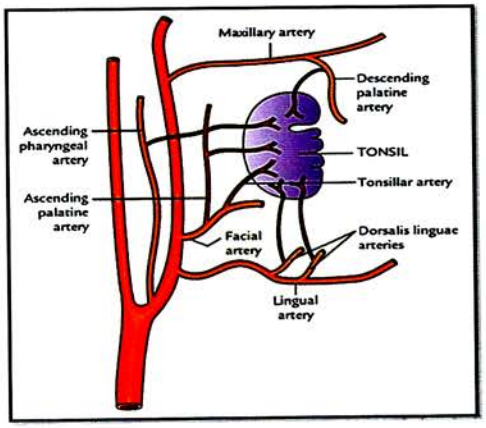
Oesophagus





3rd part

1. Superior alveolar artery → **supplies upper teeth**
2. Spheno palatine artery supplies little's area
3. Descending palatine a supplies little's area
   → greater palatine a. supplies little's area



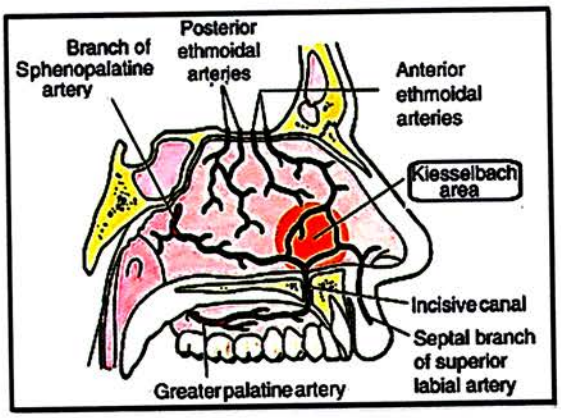
Tonsil arterial supply

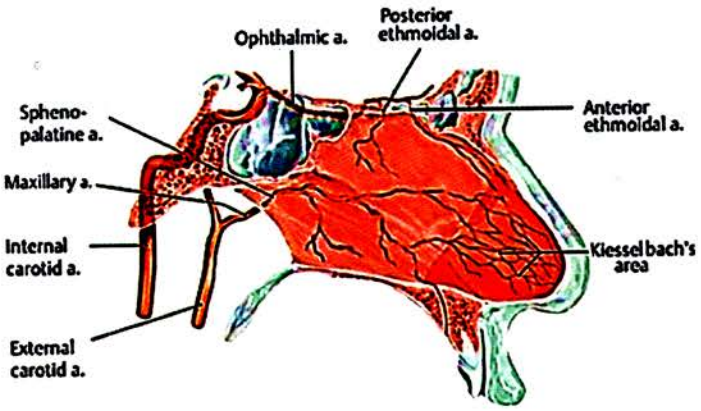
Facial artery → **ASC. Palatine artery also**
Maxillary → **des. Palatine artery**
Lingual → **dorsal lingual artery**

Nose: KIESSELBACH's plexus / Little's area of epistaxis

→ Present at antero inferior aspect of nasal septum
→ Provided by Br. of ECA & ICA
Sphenopalatine artery → br. of 3rd **part** of **maxillary artery** of ECA
Greater palatine artery → br. of descending Palatine artery of 3rd part of maxillary a.
Superior labial artery → br. of facial artery of ECA
Ant. ethmoidal artery → br. of ophthalamic artery of ICA
Post.Ethmoidal artery → br. of ophthalamic artery of ICA

Major contribution from ICA is by ant. ethmoidal artery
Spehnopalatine artery is mostly resp. for severe epistaxis
→ **for embolism, ECA branches to be approached, not ICA branches**

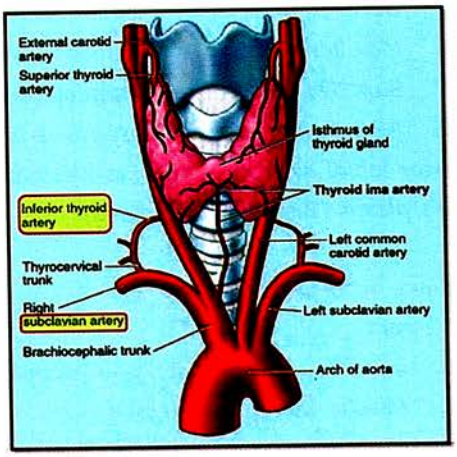




10% have thyroid IMA artery→ Br. of variable origin

1. Arch of aorta
2. Brachioceph. Trunk
3. Subclavian artery
4. ECA

→ Midline artery
→ Prone to injury during Isthmectomy



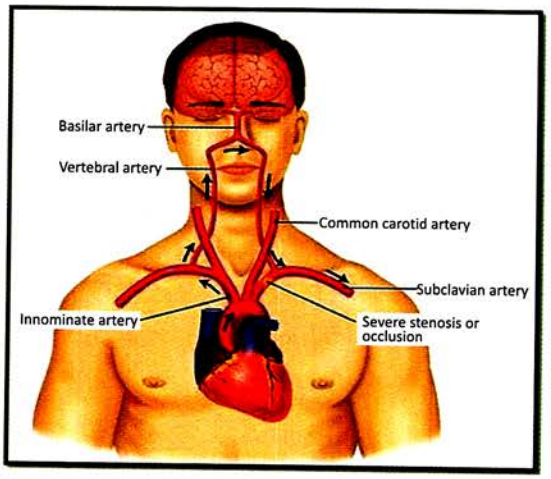
Sub clavian artery crosses the outer border of 1st rib to enter axilla to become axillary artery.
Axillary vein in axilla crosses the outer border of 1st rib to enter and become **subclavian vein.**
S.anterior is between 2 vessels (vein anterior and artery posterior)
Subclavian artery and vein running on superior surface of 1st rib in a groove.
3rd part of subclavian artery block can be given by compressing 1st rib
scalenus anterior divides subclavian artery into
1st part proximal to muscle
2nd part deep to muscle
3rd part distal to muscle

Sub clavian steal syndrome

→ subclavian artery steals blood from circle of willis to supply upper limb

Left subclavian stenosis

→ Can lead to left upper limb ischemia
→ Prevented by rt. subclavian steal syndrome
→ Ipsilateral vertebral artery has reversal blood flow
→ **Subclavian artery steals blood from circle of willis**
→ Circle of willis supplied by ICA
→ Advised **not to do heavy work on affected side**



Head & neck: Arterial supply

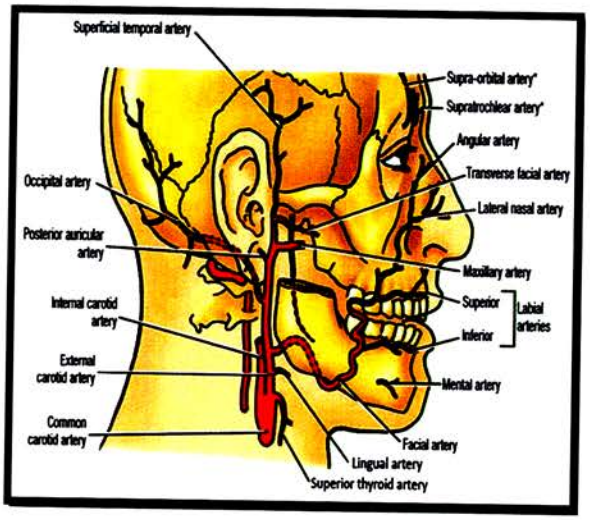
Sub clavian Artery – Branches
1st part branches
V → **Vertebral artery → supply circle of willis**
I → **Internal thoracic → supply thorax**
T → **Thyrocervical trunk → supply thyroid**

External carotid artery branches

→ **8 branches → 3 anterior, 2 posterior, 2 terminal, 1 medial**

1. Superior thyroid → supplies thyroid
2. Lingual artery → supplies tongue
3. Facial artery → supplies face
4. Post. auricular a. → supplies auricle
5. Occipital artery → supplies occipital
6. Maxillary artery → supplies maxilla
7. Sup. Temporal a. → supplies temporal bone
8. ASC. Pharyngeal a. → supplies pharynx, Et, tonsils

Superior labial artery → supplies klesselbach area of little's plexus (Br. of facial artery)



Maxillary artery (3 parts)

1st part

1. Inferior alveolar artery → **supplies lower teeth**
2. Middle meningeal artery

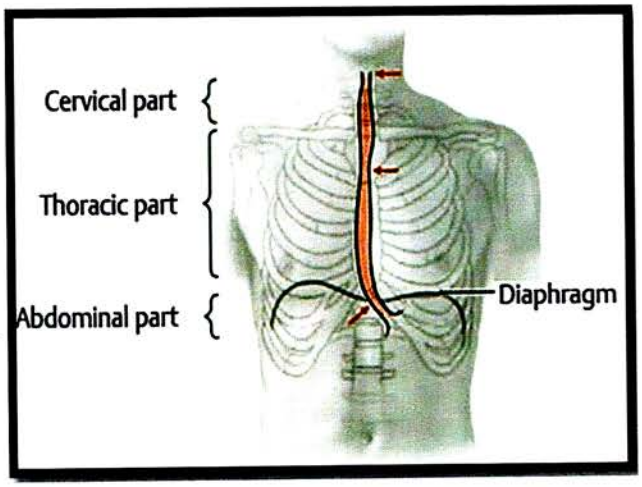
Oesophagus

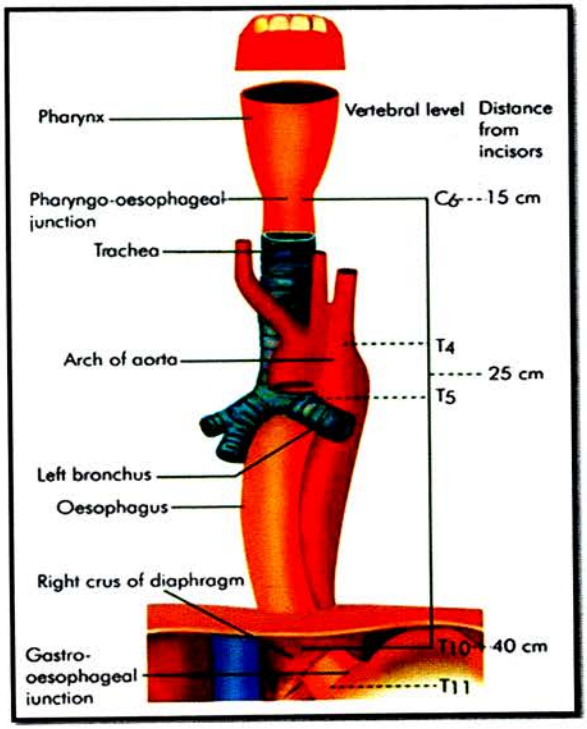
→ Length → 25 cm

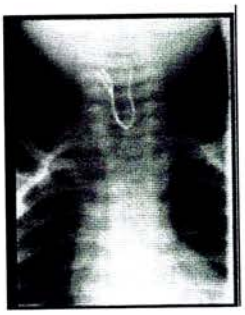
→ Beginning → C_5 lower vertebra

Passing → T_{10}

Diaphragm







Foreign Body

→ Most of foreign bodies found at **cricopharyngeal sphincter level**

- **Common in children & psychiatric patients**
- Length of oesophagoscope required is → **15 cm**

Levels from upper incisor

15 cm (C_6)→ d/t **cricopharyngeus sphincter**

23 cm → d/t **aortic arch**

28 cm → **Lt main bronchus**

25 cm (b/w T_4& T_5) → **bronchus aortic constriction**

- → **Lt atrium**

40 cm (T_{10}) → **While passing through diaphragm**

At T_{11} **continuous as stomach**

Scalenus Anterior muscles

Relations in neck region

Origin → from cervical vertebrae

Insertion on the inner border of 1st rib

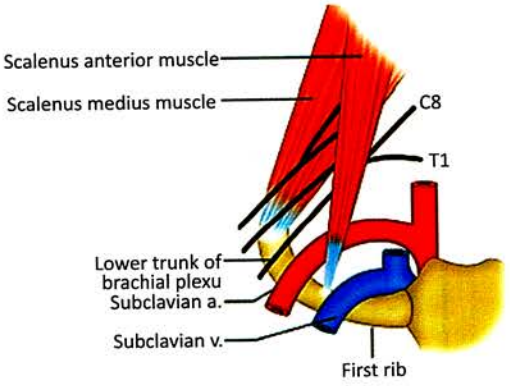
(scalenus medius attaches on the superior surface of 1st rib)

Inter scalene triangle

→ Present between scalenus anterior and scalenus medius

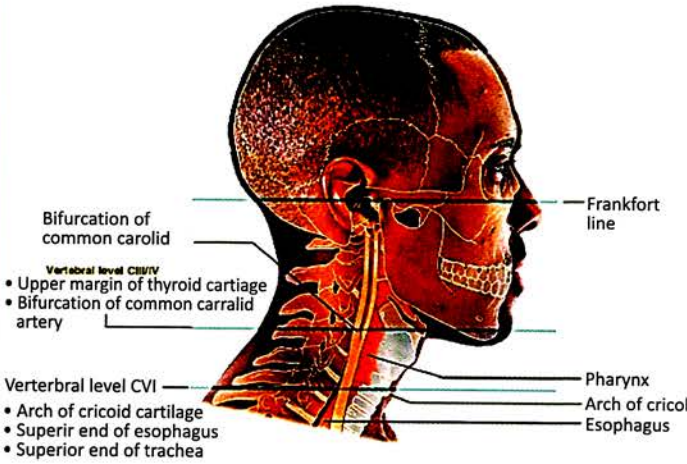
→ Brachial plexus block given here for multiple fracture pain

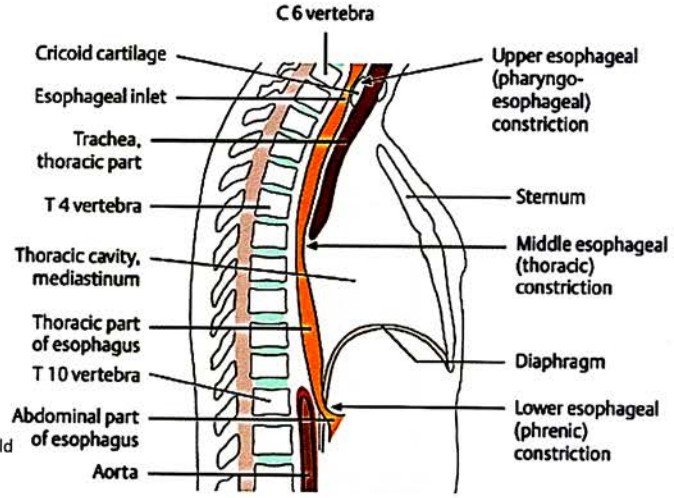
→ Block given lateral to s.anterior muscle



C6 lower border

→ Cricoid cartilage
→ Crico-pharyngeal sphincter
→ Ending of larynx, pharynx
→ Beginning of trachea & oesophagus



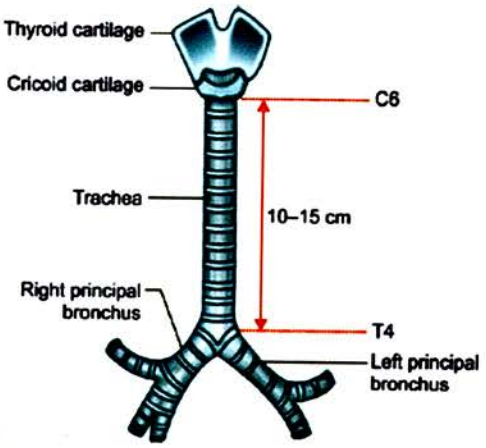


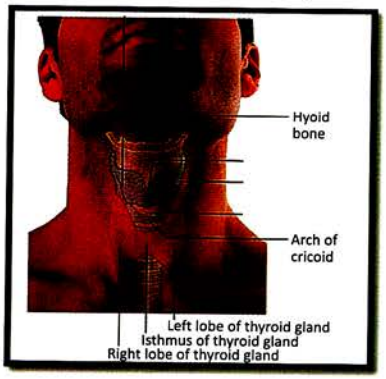
Larynx extent

→ Adult male → C3-C6
→ Adult female → still higher
→ Infant while swallowing → **reaches upto atlas vertebra**

Trachea

→ Length→ **approx.. 11 cm**
→ Bifurcation → **disc b/w T_4. T_5 vertebra > upper border of T_5> upper border of T_6 (deep inspiration) lower border of T_4 (cadaver)**
→ 16-20 C- shaped tracheal rings present in trachea in tracheostomy
→ Isthmus thyroid gland to be cut **(in front of 2,3,4> 2,3,>3 trachea Rings)**
→ 'C' 2&3 rings cut
→ Carina → present at bifurcation
→ **Angle b/w rt & it principal bronchus → 70 degree**





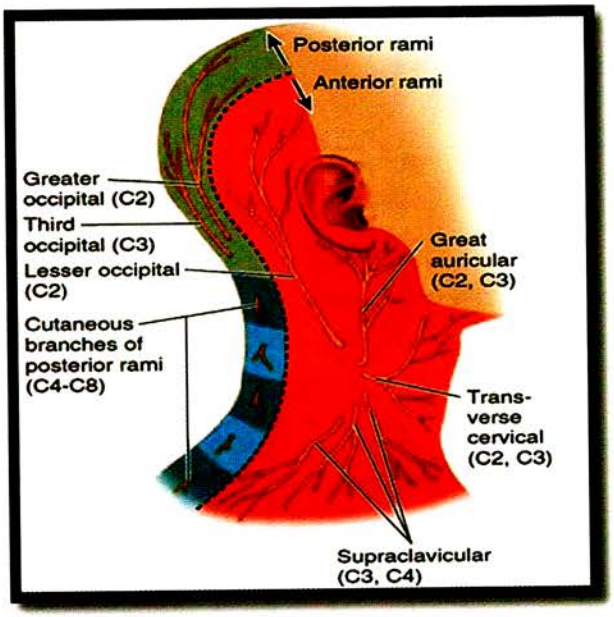
Cervical plexus

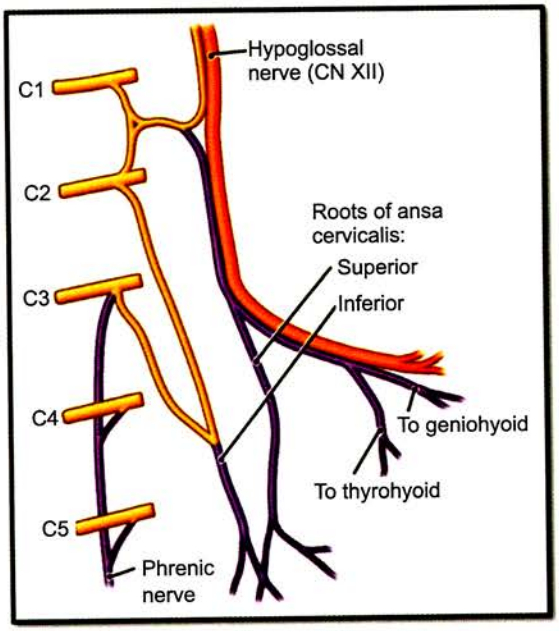
Cervical plexus branches

→ At posterior border of sternocleido mastoid mid-point cervical plexus gives branches

1. **Greater auricular nerve** → Supplies greater part of auricle
   → Skin on the angle of mandible
2. **Lesser auricular nerve** → Skin behind the auricle
3. **Transverse cervical nerve** → Supplies neck region transversely
4. **Supra clavicular nerve** → Goes to supra-clavicular region

→ **All branches coming from anterior primary ramus**





C_1 **fibres**→ Carried by CN 12 & supplies thyrohyoid & geniohyoid
→Contributes to superior root of ansa-cervicalis

C_2, C_3 **fibres**→ Contributes to inferior root of ansa-cervicalis supplies omohyoid, sternohyoid & stabilizes larynx

Phrenic nerve

→ Comes from cervical plexus (C_3, C_4) & C_5
→ Major root value C_4
→ Sensory motor nerve

Motor to → diaphragm

Sensory to → central portion of diaphragm carry sensations from pleura, pericardium, peritoneum near midline responsible for referred pain on shoulder (C_4 dermatome)

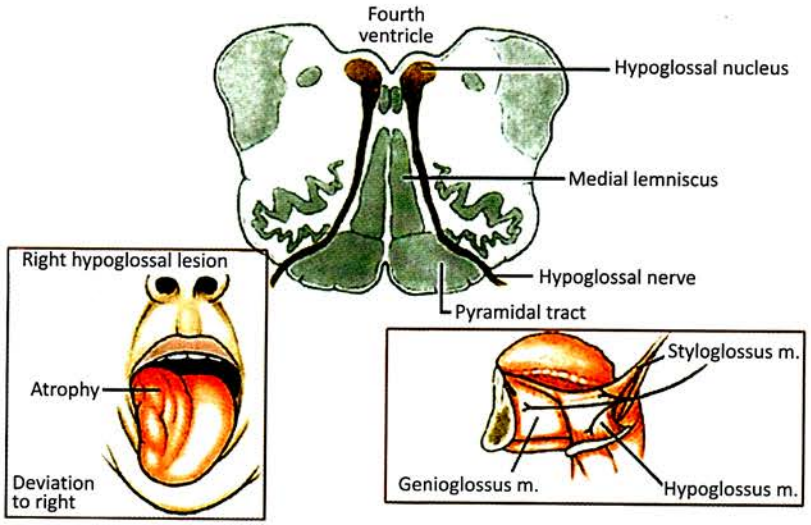
Vertebral landmarks

→ **Common carotid artery** bifurcates & sup. border of the lamina of the thyroid cartilage of larynx

→ **CCA bifurcation →C3**
→ **carotid body & carotid sinus → C3**
- Carotid body tumor present here
- CB massage done here

.....

Hypoglossal nerve



Hypoglossal nerve (CN 12)

→ Pure motor nerve

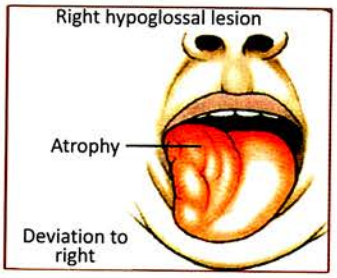
→ CN 12 nucleus present **at the floor of 4th ventricle** in upper medulla near the midline

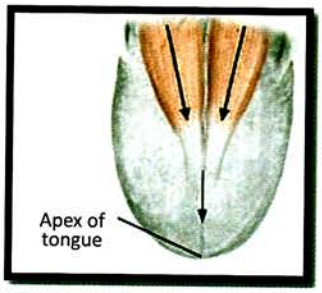
→ Gives CN 12 → exits b/w **pyramid (anteriorly), olive (posteriorly) & supplies tongue muscles except palatoglossus (supplied by VAC)**

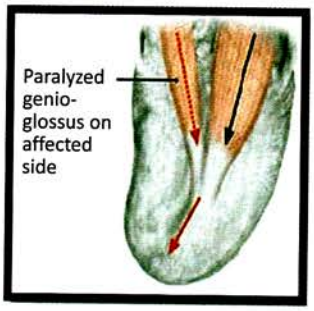
RT sided hypoglossal nerve injury

→ Tongue **deviates to Rt. Side (I/L side)**

→ Pharynx **deviates to Lt. Side (C/L side)**







Genioglossal muscle

→ Genioglossal muscle **'AIM' the tongue**

A Anterior → protrusion of tongue

I Inferior → depression of tongue

M Medial

→ In Rt. Sided lesion → Balance lost, **Lt. genioglossus is more powerful**

→ **Tongue deviates to rt. Side (same side of lesion)**

→ Skeletal muscle

→ **Safety muscle of tongue**

→ Prevents back falling of Tongue into the resp. tube

→ **In post epilepsy unconsciousness**

1. Turn the patient to one side
2. Pull the tongue outside

Because drive to genioglossal muscle is lost (deep unconsciousness) during sleep drive is maintained (no deep unconsciousness)

→ **In sleep apnea syndrome**

Culprit muscle → **genioglossus**

Drives reduced → Tongue fall backwards → wakes up rt by prosthetic sx to be done to enlarge respiratory tube pacemaker for genioglossal muscle **(future option)**

Investing fascia

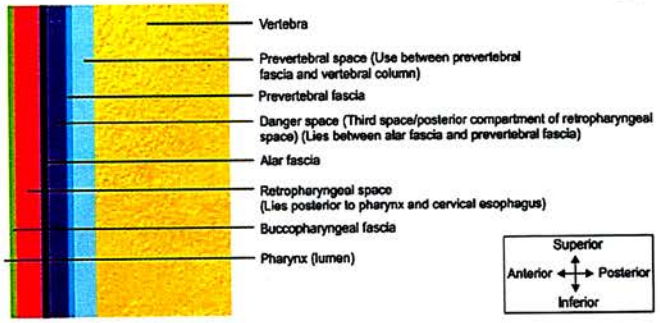
Pre-vertebral fascia

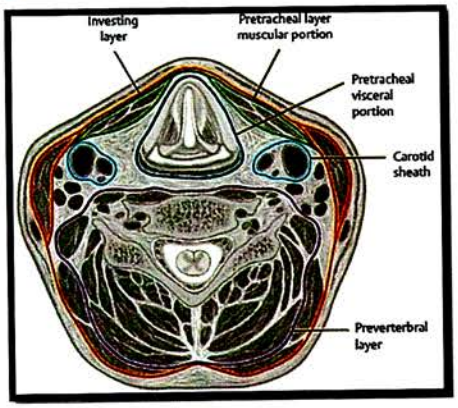
→ Encloses para vertebral muscles

Pre tracheal fascia

→ Goes antero lateral to trachea

→ Continues posteriorly around pharynx & oesophagus as buccopharyngeal fascia





Pre Tracheal Fascia

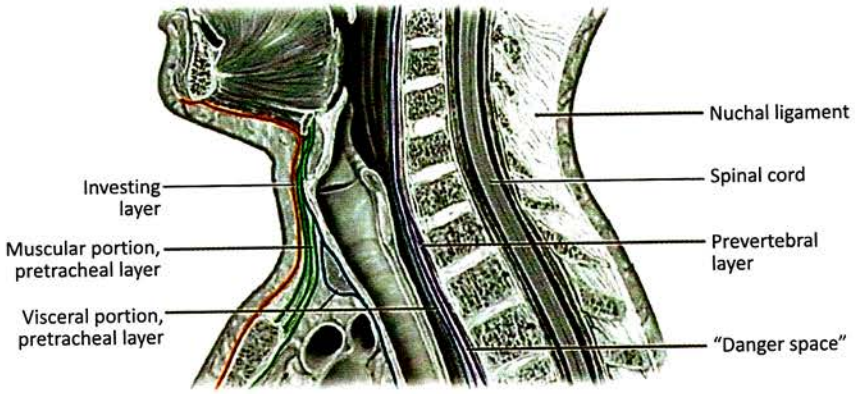
1. **Visceral** → encloses thyroid, trachea, oesophagus
2. **Bucco pharyngeal** → continuation of pretracheal fascia
   → retro pharyngeal space present behind pharynx & buccopharyngeal fascia

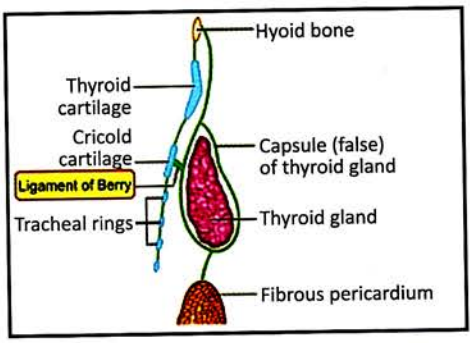
Ligament of Berry / posterior suspensory ligament

→ Modification of **deep cervical fascia**

→ Fixes thyroid gland to cricoid cartilage of larynx anteriorly

→ d/t which **thyroid gland moves up & down during deglutition**



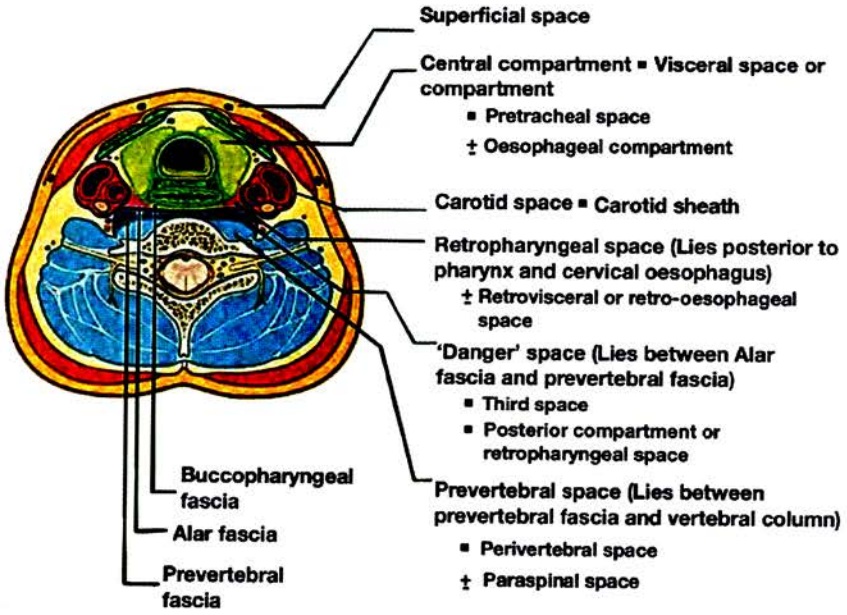


Neck fascia & spaces

1. Investing fasica
2. Pre tracheal fascia (anterior) → buccopharyngeal fascia (posterior)
3. Retropharyngeal space
4. Pre vertebral space
5. **Pre vertebral fascia → splits into 2 layers**
   a.) Alar fascia (anterior)
   b.) Prevertebral fascia proper (posterior)

Dangerous space present b/w these 2 layers

- **potential space**
- **spreads infections into mediastinum**



Brachial plexus

- → Present at floor of post. /e
- → Present in inter scalene triangle (b/w Sc. Anterior & Sc. Medius)
- → Pulls the paravertebral fascia into axilla → axillary sheath
- → Present **behind & lateral** to scalenus anterior (most posterior)

Parotid gland

- → Largest salivary gland
- → **Stenson's duct** of parotid gland opens **opposite the upper 2nd molar in vestibule**

Relations

Deeper → pharynx

Anterior → mandible

Behind → mastoid

Anterior → ramus of mandible

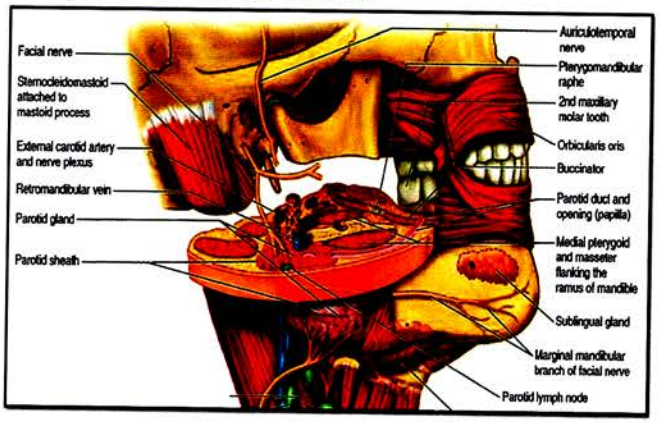
→ masseter inserted on lateral surface

→ medial pterygoid inserted on medial surface

Posterior → mastoid bone

→ SCM inserted on lateral side

→ post. belly of digastric inserted on medial surface



Structures passing through parotid gland

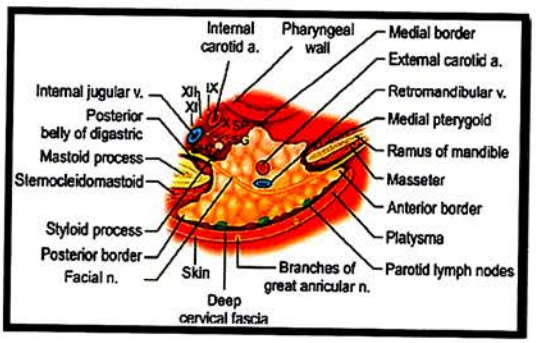
Retromandibular vein → passes through parotid gland

External carotid artery v

Sympathetic plexus (a/w ECA)

Facial nerve

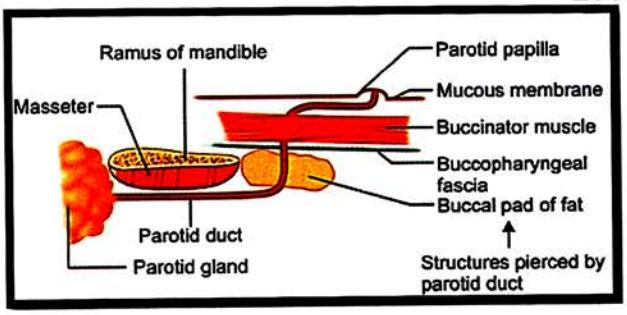
- → Passes in the middle of gland
- → Do not supply parotid gland
- → Creates a surgical plane
- → **Deep → LN are less**
- → **Superficial → LN are more**



Medial → pharynx

→ Styloid process related to parotid gland

→ **Stenson's duct** of parotid passes **lateral to masseter & pierces buccinator** to open opp. the upper 2nd molar.



Ear

Embryology

Neural plate ectoderm → CNS

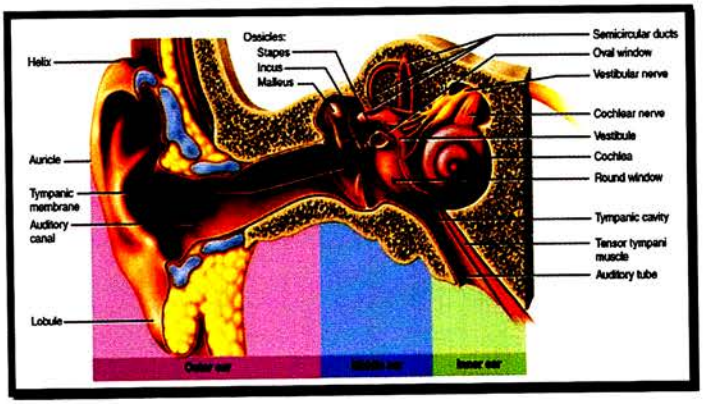
NCCS → PNS

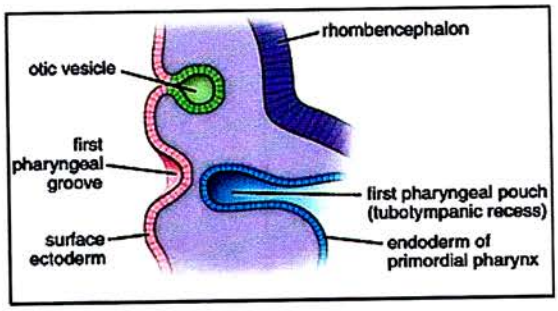
Ectodermal placodes

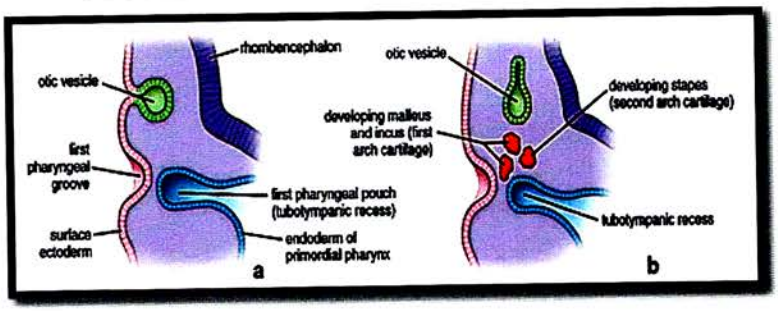
→ Distributed among surface ectoderm cell

→ Forms some ganglia

→ Form otic placode on D-20







→ Pharyngeal cleft 1 lined by surface ectoderm

→ forms external auditory meatus

→ middle ear cavity formed by **endoderm** of pouch 1 (mainly) & (partly)

→ forms middle ear cavity & ET epithelium

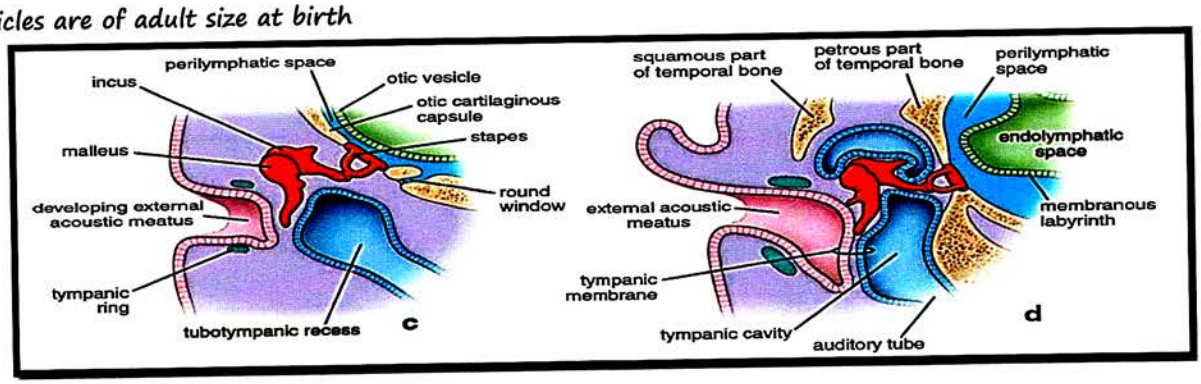
→ Malleus, Incus } comes from 1st arch (Meckel cartilage) (sec. mesenchyme)

Stapes → comes from 2nd arch (Reichert's cartilage) (sec. mesenchyme)

→ Outer margin formed by otic cup/ vesicle

→ Foot plate formed by NCCs → sec. mesenchyme → Reichert's

→ ossicles are of adult size at birth



Optic Placode → otic Pit → Otic vesicle Inner Ear

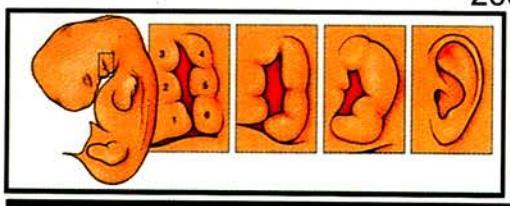
→ Inner ear

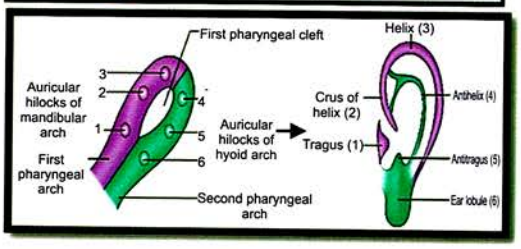
→ Formed in territory of hind brain (Rhombencephalon)

a. VESTIBULE — utricle, saccule

b. 3 SEMICIRCULAR CANALS

c. COCHLEA





Tympanic membrane

outer epithelium → ectodermal

Inner epithelium → endodermal

Connective tissue → mesodermal

Endolymph

→ Ultra filtrate of blood

→ Drains into CSF

→ Present inside membranous labyrinth

Perilymph → present b/w membranous & bony labyrinth

Middle ear cavity boundaries

→ Lateral wall → tympanic membrane

→ Roof → tegmen tympani

→ Ant. wall → ET

→ Medial wall → inner ear

Inner ear

→ cochlear nerve → for hearing

→ vestibule→ for balance

→ SCC → for angular motion

→ vestibule cochlear nerve

→ passes internal auditory meatus

→ for balance

Auricle nerve supply

Greater auricular nerve → greater part of auricle laterally & medially (lobule)

Lesser occipital nerve→ supplies medial part of upper auricle

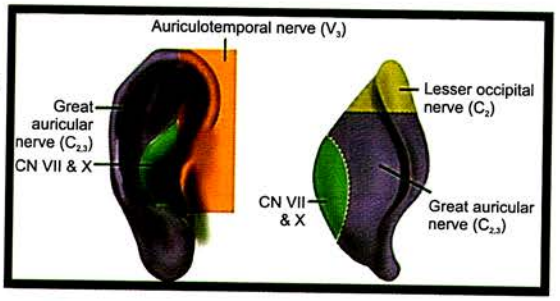
Auriculo temporal nerve

→ supplies tragus

→ auricular br. of vagus

→ facial n. carries it

Facial n. injury causes loss of sensation here



Auriculotemporal nerve (V3) supplies

Tragus

Ant. part of auricle

Temporal area

Greater auricular nerve supplies
Greater part of auricle
Laterally
Medially (lobule) (medial upper part by lesser auricular nerve)
Vagus supplies root

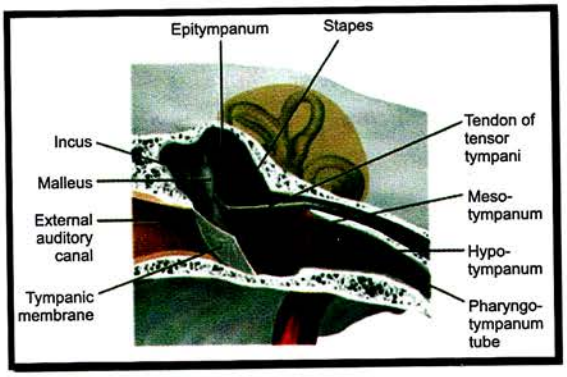
Middle ear cavity

→ Contains ossicles
→ **Divided into**
Epitympanum (superior)
Mesotympanum (middle)
Hypotympanum (inferior) → towards auditory tube

Ossicles

Malleus → **most lateral**
Incus
Stapes → **most medial**
Mesotympanum
→ Narrowest part (2mm)
→ Contains stapes, pars tensa of TM
Epitympanum
→ Largest part (6 mm)

→ Contains most of malleus & incus
Hypotympanum (4 mm)
Malleus → attaches to mm
Stapes → attaches to medial wall of MEC
→ stapes foot plate attaches to oval window
→ Epitympanum → contains ossicles (most part) & tympanic membrane
→ **Tensor tympani → dampens sound**
Stapedius → dampens sound (pulls stapes back),Injury to above muscles cause → Hyperacusis



→ **Boundaries**
Roof → **Tegmen tympani**
Posteiror→ **mastoid antrum**
Anterior → **ET (nasopharynx)**
Medial → **cochlea (inner ear)**

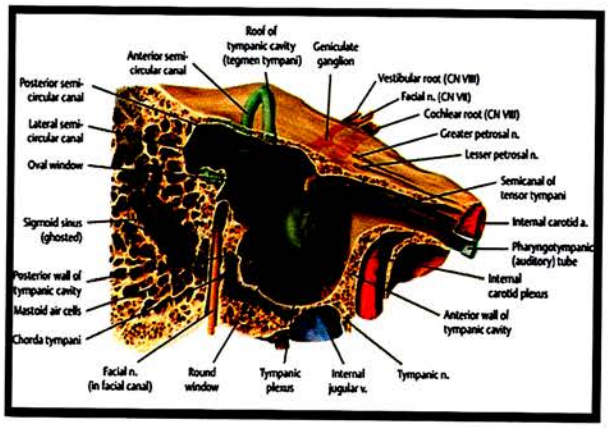
Roof
→ **By Tegmen tympani**
→ Separates MEC from cerebrum (temporal lobe)
→ **Anterior /superior semi circular canal produces eminence**
→ Arcuate eminence at floor of cranial cavity
→ Lateral scc produces impression over medial wall of MEC, **just above the course of facial nerve**

Facial nerve course

- → Accompanied by **vestibule cochlear nerve**
- → Both enter internal auditory meatus
- → Facial nerve takes a bend (external genu) in the **petrous part of temporal bone** & have geniculate Ganglion
- → Then gives **3 branches** & runs on medial wall for a brief distance & then runs on post. wall of MEC & exits cranial cavity at stylomastoid foramen
- → In MEC, it gives greater petrosal nerve
- → Runs at floor of cranial cavity towards foramen lacerum and joins with deep petrosal nerve (br of T1 sympathetic plexus) & forms **vidian nerve of pterygoid canal**

Lesser petrosal nerve

- → accompanies greater petrosal nerve
- → carries **preganglionic fibres** towards the parotid gland coming from tympanic plexus
- → **Tympanic plexus** present on **medial wall of MEC** (basal turn of cochlea producing elevation → promontory)
- → **supplies MEC, ET, mastoid antrum & air cells, TM (inner surface)**
- → contributed by
  Tympanic br. of glosso pharyngeal nerve (main)
  T1 sympathetic plexus around ICA
  Branch from **geniculate ganglion**



Anterior wall structures

- → ICA
- → ET
- → Tensor tympani

Medial wall structures

- → Promontory
- → Oval window (postero superior)
  Round window (postero inferior)

Posterior wall structure

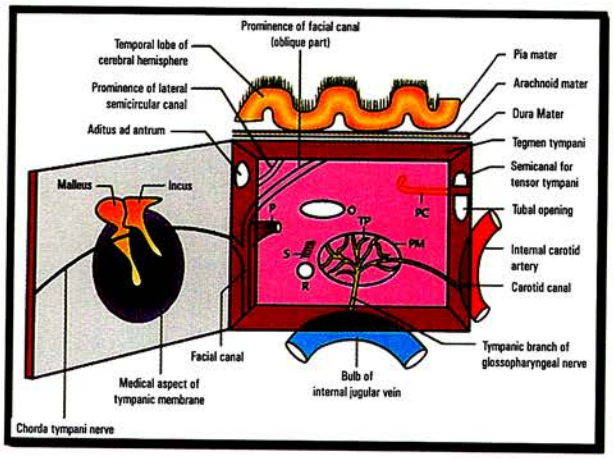
Mastoid antrum/aditus
Facial nerve course
Pyramidtendon of stapedius muscle attaches here, stapedial pulls staepes posteriorly (stapedial reflex)prevents damage)

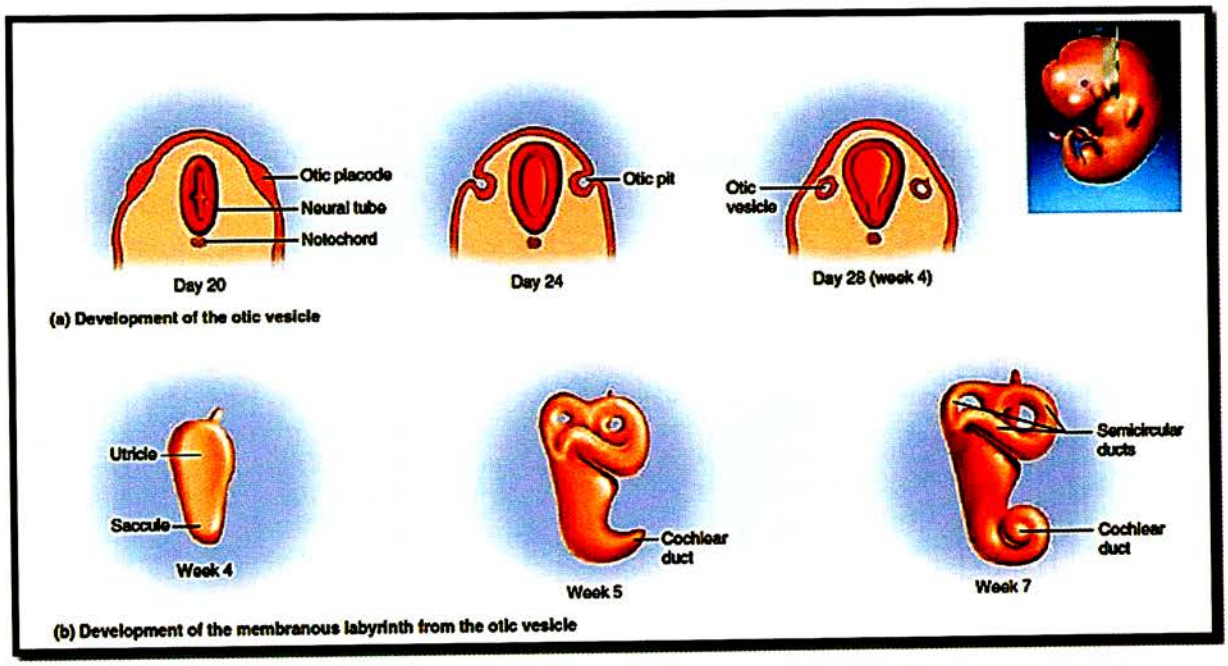
Lateral wall structure

Tympanic membrane

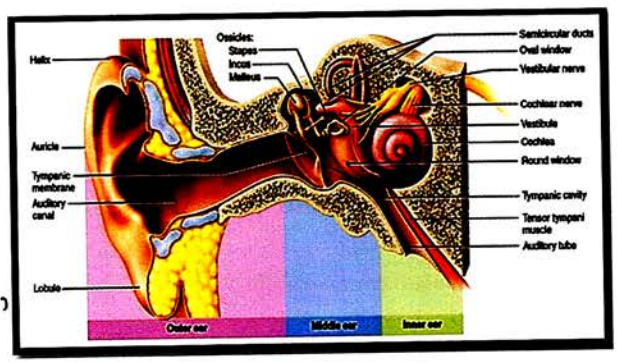
Floor structure

Br. Of CN-IX
Internal jugular vein (continuation of sigmoid sinus



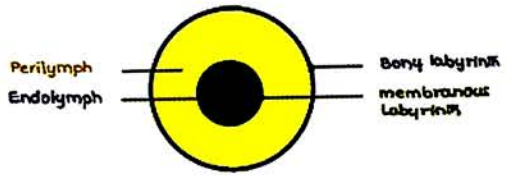


→ Foot plate of stapes fixed to Oval window
↓
Vibrations of Footplate of stapes
↓
Perilymph vibrations in scala vestibuli
↓
continues as Scala tympani
↓
continues to round window (covered by Tympanic membrane)



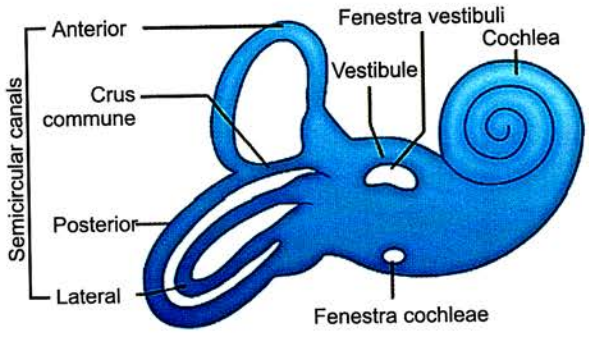
Inner Ear

Labyrinth
Outer bony labyrinth
Inner membranous labyrinth



Bony Labyrinth

Includes cochlea (anteriorly)
Vestibule (middle)
SCC (posteriorly)



Cochlea

→ Has 2.75 turns
Basal turn → receives high frequency sound
Apical turn → receives low frequency sound
→ Spiral ganglion → **cochlear ganglion**

Vestibule

→ Membranous labyrinth → **utricle & saccule**

→ Saccule connecting with cochlear duct

Utricle connecting with SCC

Bony Labyrinth	Membranous Labyrinth (within bony labyrinth)
Cochlea	Cochlear duct
Vestibule	Utricle and Saccule
Semicircular canals	Semicircular ducts

Endolymph & perilymph

→ Ultra filtrate of blood

→ Formed by capillary plexus

→ Drains into extra dural venous plexus

Function

1. Equilibrium → by vestibule → linear acceleration
   Scc→ Angular acceleration
2. Hearing → by cochlear nerve

Membranous labyrinth

→ Cochlear duct

→ Utricle

→ Saccule

Ductus reunion

→ Cochlear duct communicating **with saccule**

Ductus Endolymphaticus

→ Utricle communicating with saccule

Saccus endolymphaticus → **subdural > Intra dural> Extra dural**

Inner ear – sound conduction

Foot plate of stapes fixed to oval window

↓

Vibrations of footplate of stapes

↓

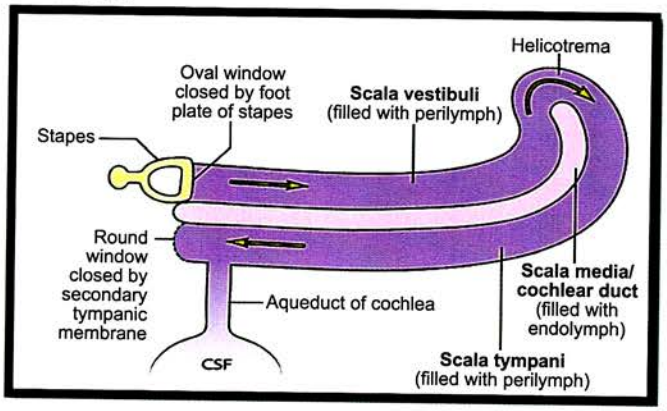
Perilymph vibrations in **scala vestibule**

↓

Continues as scala tympani

↓

Continues with round window (covered by tympanic membrane)



Scala media

→ Filled with endolymph

→ Hair cells present here **detects vibration** & passes information to cochlear nerve

Organ of corti

→ Located at cochlear duct area

→ Transducer

- changes **mechanical energy → electrical energy**

→ Contain **hair cells**

→ Contains stereo cilia

- **acts as transducers**
- **converts mechanical energy into electric energy**

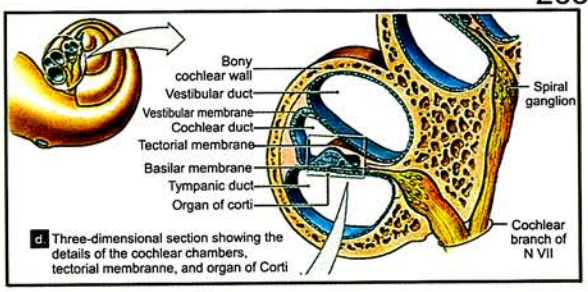
Cochlear nerve

→ carry 95% of contribution from inner cells

→ carry 5-10% of contribution from outer cells

Stria vascularis

- secretes endolymph
- endolymph receives vibration and moves tectorial membrane which stimulates hair cells



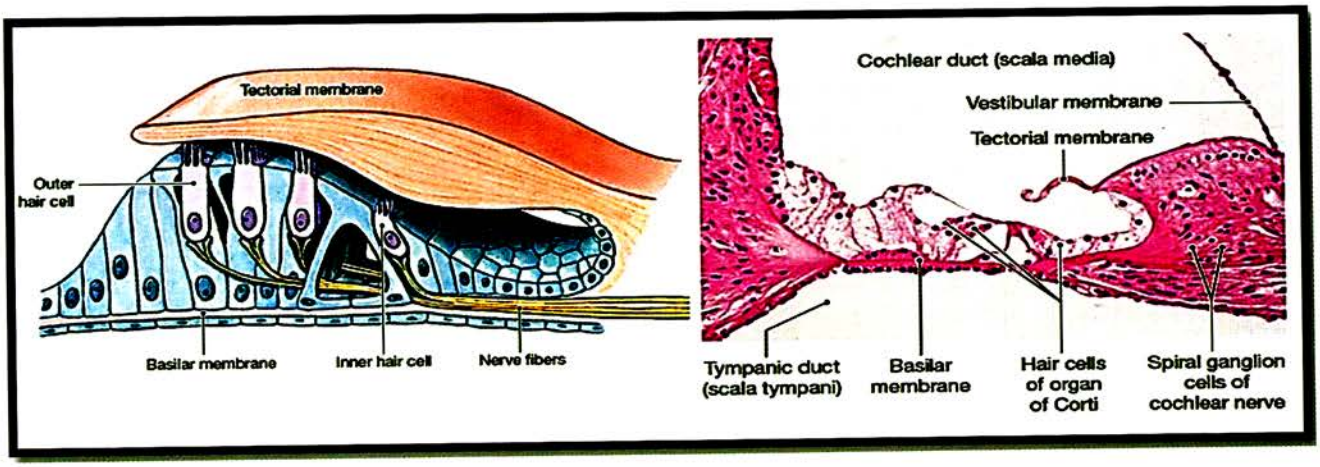
Vestibular /Reissner membrane → separates scala vestibule &scala media

Basilar membrane → separates scala media & scala tympani

Tectorial membrane

→ present inside scala media

→ **endolymph vibration** → vibrates tectorial membrane → stereocilia deviated → **sound production**

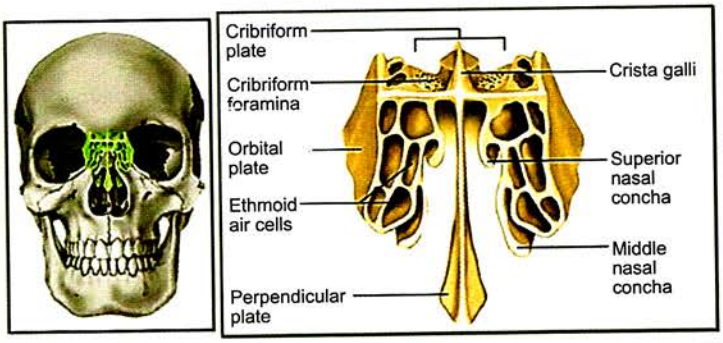


Nose

Ethmoid bone

→ Hollow from inside

→ Ethmoid air sinus present forms medial wall of orbit (papery min)

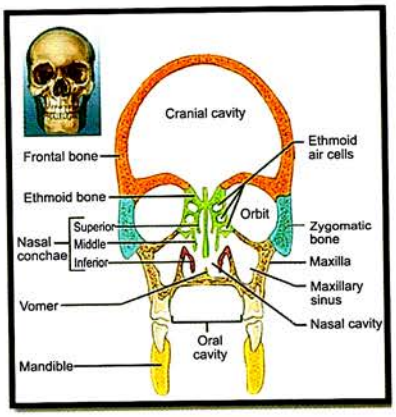


Orbit

Roof formed by **frontal bone**

Lateral wall by **zygomatic bone**

Floor by **maxilla bone**



Nasal concha / Turbinate

Superior & middle turbinate

Present in **lateral wall of nose**

Cribriform of plate of ethmoid

→ # at the floor of ACF → CSF rhinorrhea

→ passage of **axons of olfactory nerve** at the floor of ACF

→ forms roof of nose

Crista galli

→ Midline projection **at the floor of ACF**

Inferior choncha

→ Separate bone

→ Articulate with maxilla bone

- forms floor & medial wall of orbit
- form **roof of oral cavity**
- palate is formed by palatine & maxilla bone
- forms **floor of nasal cavity**

Perpendicular plate of ethmoid

→ Forms nasal septum from above (vomer forms nasal septum from below)

→ Ethmoid air sinuses (pneumatic bone)

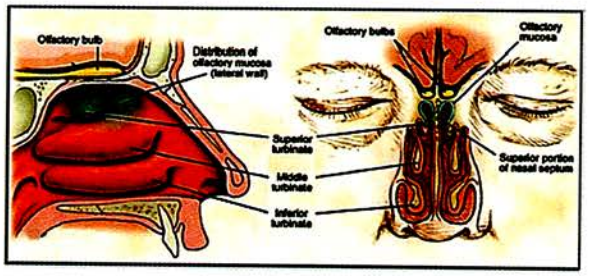
Olfactory mucosa

→ Nasal mucosa above the superior turbinate

→ Olfactory neuron bodies present here

Shortest cranial n → olfactory n.

Longest cranial n → vagus



Nasal septum

Formed by

1. Perpendicular plate of ethmoid from above
2. Vomer from below
3. **Nasal spine of frontal bone**
4. Crest of nasal bone
5. Crest / rostrum of sphenoid at the roof of nasal cavity
6. Nasal crest of maxillary & palatine bone

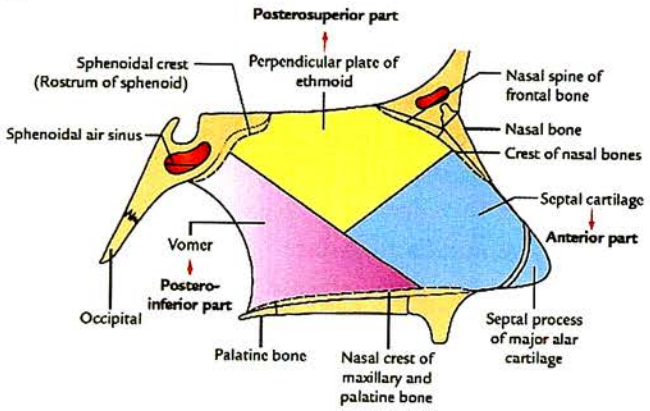
Schindylesis → suture at the roof of nasal cavity

→ sphenovomerine joint rostrum of sphenoid with **Ala of vomer**

Lateral wall

Bones

1. Middle turbinate **comes from ethmoid bone**
2. Superior turbinate **comes from ethmoid bone**
3. Inferior turbinate
   Separate bone
   Articulate with maxilla & lacrimal bone
4. Lacrimal bone
5. Ethmoid bone **(labyrinth)**
6. Maxilla bone
7. Palatine bone **(perpendicular plate)**
8. Sphenoid bone **(medial pterygoid plate)**
9. Nasal bone
10. Uncinate process of ethmoid

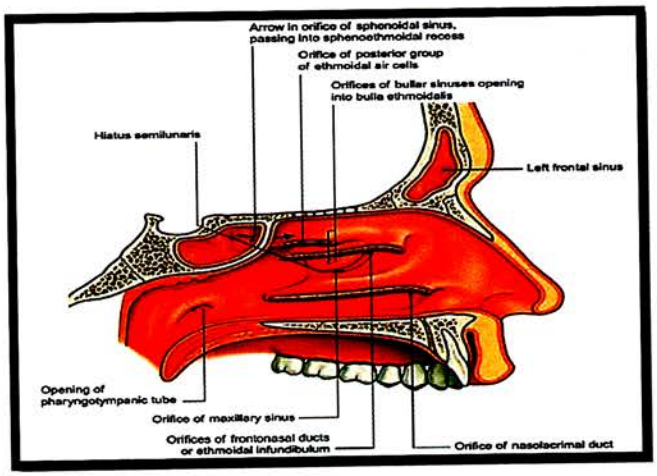


Largest turbinate → inferior turbinate
Largest meatus → inferior meatus

Openings

1. At ant. end of inf. Meatus → **nasolacrimal duct**
2. Behind the nasal cavity & inferior turbinate & in nasopharynx → **ET opens**
3. Hiatus semilunaris→**situated in middle meatus**

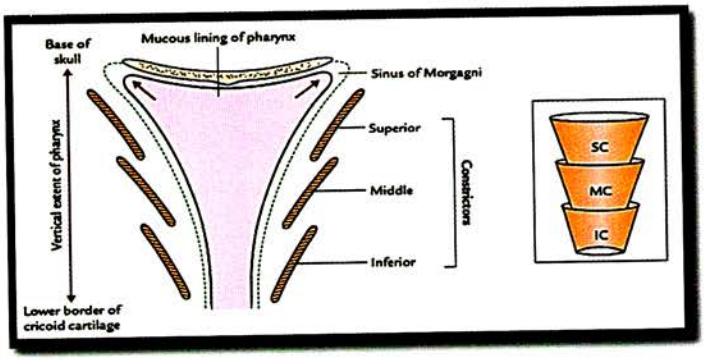
→ **opening of frontal sinus, maxillary sinus, ethmoidal sinus**

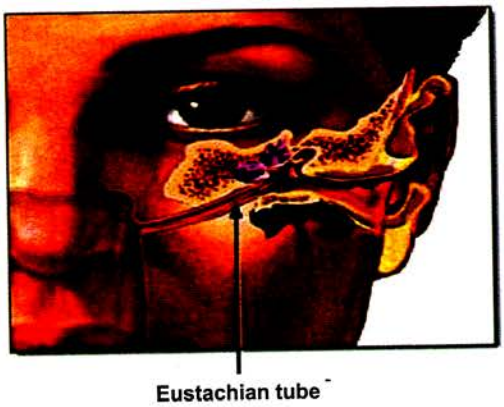


Direction of nasolacrimal duct

→ Downward ,Backward, Lateral

Pharynx





→ Opening of ET
→ Present **behind the inferior turbinate in lateral wall of nose**
→ Fossa of rosenmuller
→ **Behind opening of ET**
→ Adenoids

Pharyngeal constrictors

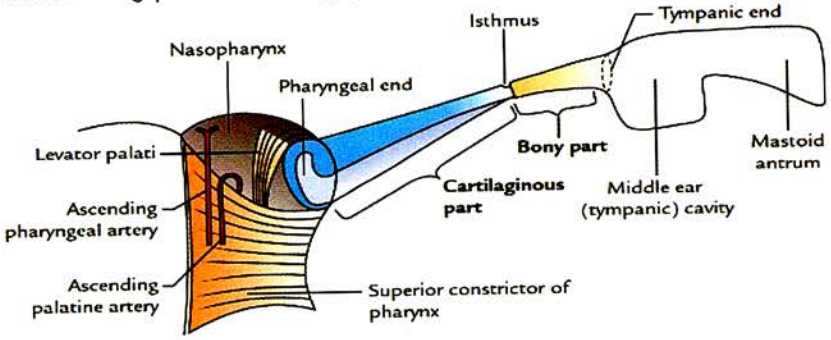
Superior pharyngeal constrictor
Middle pharyngeal constrictor
Inferior pharyngeal constrictor

Levator veli palatini

→ **Elevates palate**
→ **Opens** Eustachian tube
→ Comes along with ET in sinus of morgagni

Sinus of morgagni

→ Space b/w **base of skull & superior pharyngeal constrictor**
→ Structures passing through SOM
1. Eustachian tube
2. Tensor veli palate
3. Ascending pharyngeal artery (medial br. of ECA)
→ supplies ET & pharynx and tonsil
4. Ascending palatine artery (br. of facial artery)



Oropharynx contents

Palatine tonsil

Passavant's ridge

→ closing mechanism of oropharynx from nasopharynx

→ formed from superior pharyngeal constrictor

with palatopharyngeus muscle

→ avoids food entering into nasopharynx

Laryngo pharynx

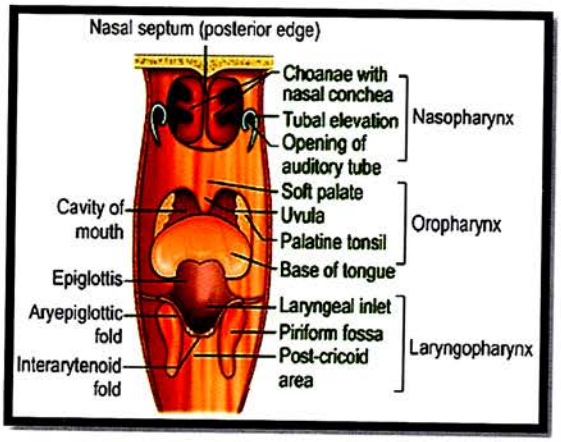
→ pyriform fossa

→ present lateral to aryepiglottic fold

→ filled with saliva in **painful situations (tonsillitis)**

→ lateral to midline

→ entry point of larynx



Eyeball Development

EPIBLAST

3 Germ layers

ENDODERM

MESODERM (Primary)

ECTODERM

NEURAL PLATE ECTODERM

CNS → Diencephalon → ① Retina, ② Optic nerve

EPITHELIUM OF DIENCEPHALON

③ Epithelium of Ciliary Body

④ Epithelium of IRIS

⑤ Muscles

Sphincter pupillae

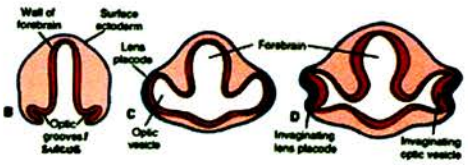
Dilator pupillae

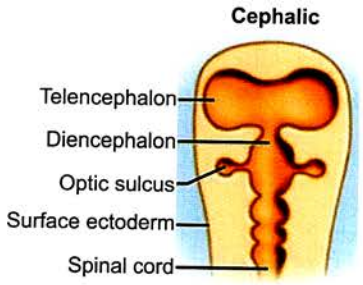
NCCs (4th Germ layers)

SEC. MESODERM OF EYE BALL (MOST OF EYE BALL)

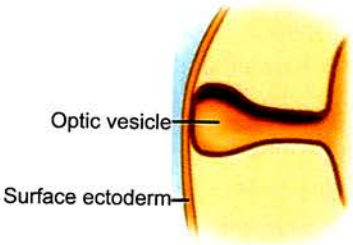
SURFACE ECTODERM

1. Cornea (1st layer)
2. Eye lens

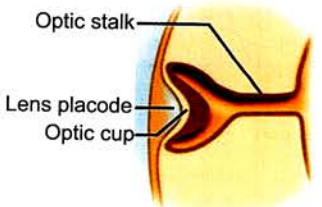




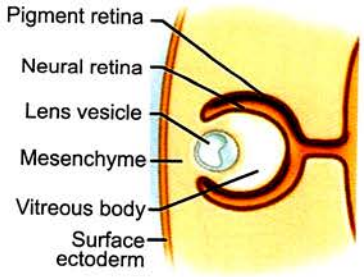
(a) Day 24



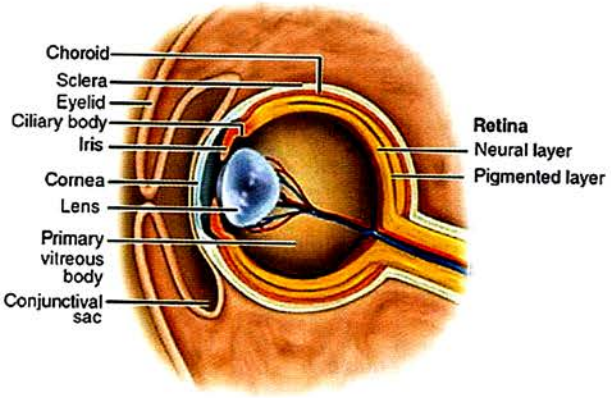
(b) Day 28



(c) Day 32



(d) Day 33



(e) 5 months

Diencephalon

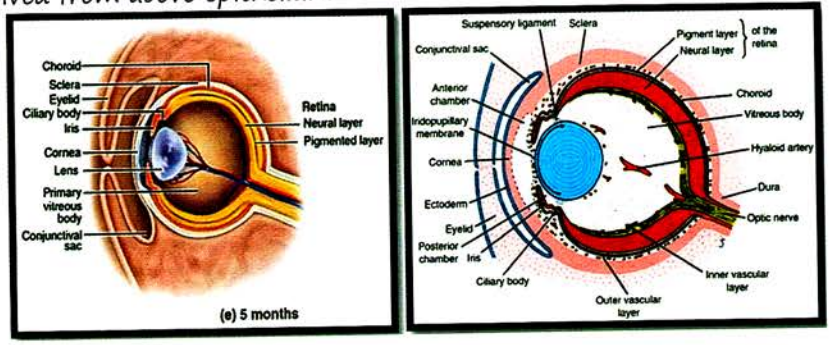
Optic Groove | Sulcus → Optic vesicle → Optic cup → Retina, Optic nerve

Surface ectoderm Cornea (1) and eye lens

Ora serrate → here neural layer becomes non neural

Iris & ciliary body covered by non neural epithelium & pigment epithelium

→ sphincter pupillae & dilator pupillae derived from above epithelium



NCC (secondary mesoderm) derivatives

Most of eye ball

Connective tissue

All layers of cornea **except 1st layer**

Vitreous

Scelra, choroid

Dura mater

Orbit

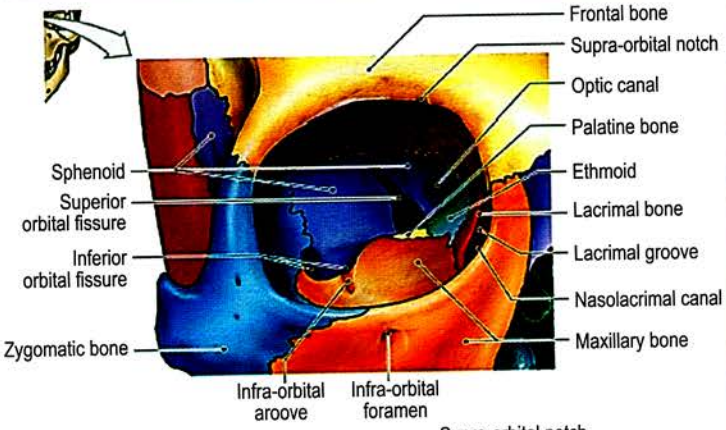
Bony boundaries

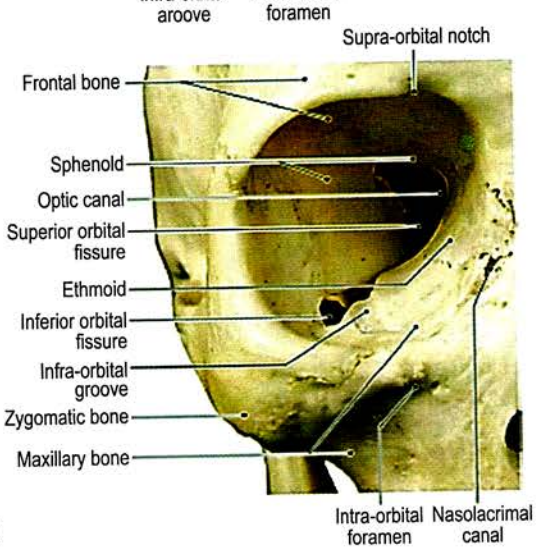
Roof → Frontal bone
lesser wing of sphenoid
with optic canal

Lateral wall → zygomatic bone
greater wing of sphenoid

Floor → maxilla **(major contribution)**
zygomatic bone
palatine bone **(small piece)**

Medial wall → maxilla **(most anterior)**
lacrimal bone
ethmoid bone
Body of sphenoid





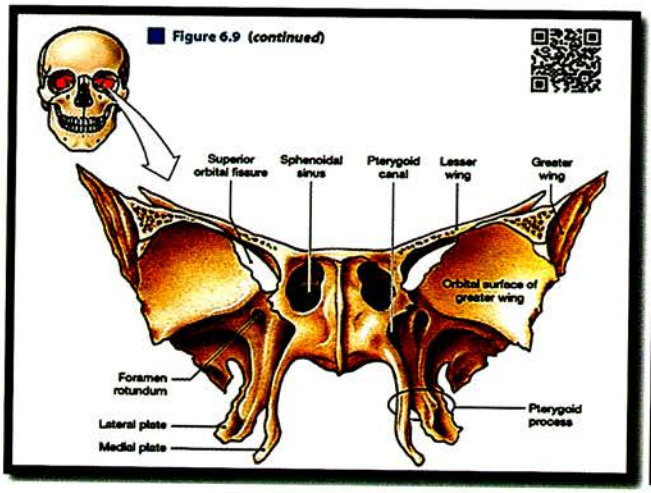
Inferior orbital fissure → junction of lateral wall & floor

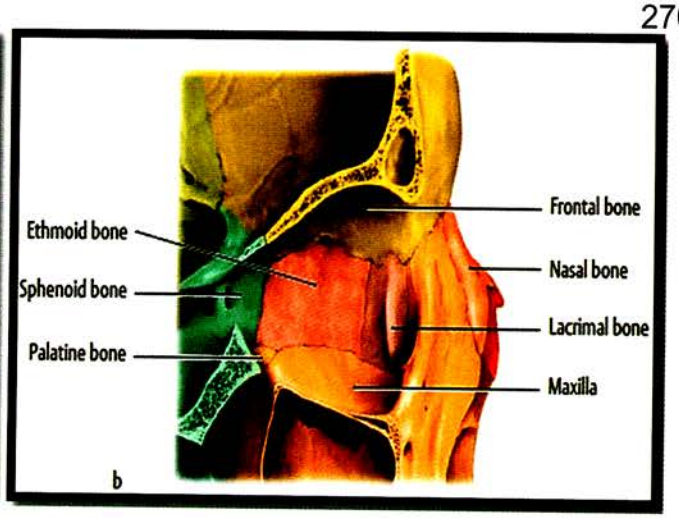
Superior orbital fissure → gap b/w lesser wing, greater wing of sphenoid

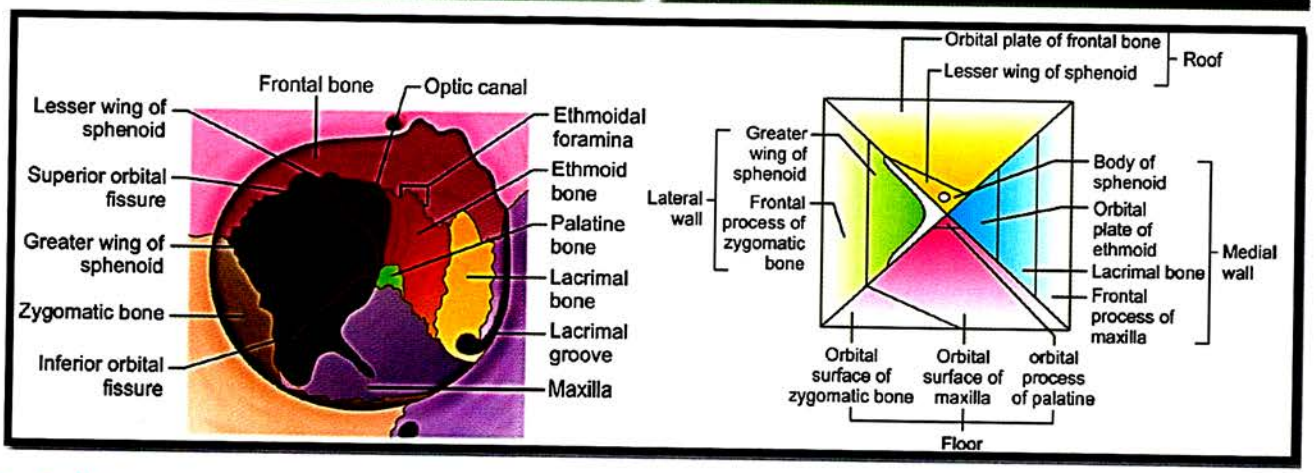
Optic canal → present b/w less wing & body of sphenoid

Blunt trauma to orbit **(blowout fracture of orbit)**

→ floor damaged
→ maxilla broken
→ protrusion of contents in maxillary sinus occurs
→ medial wall damaged
→ ethmoid bone also damaged







Eye ball muscles

→ **Skeletal muscles controlled by somatic nervous system**

→ **All muscles are inserted on sclera**

Superior oblique muscle

Inferior oblique muscle

→ **origin** → *floor of orbit*

→ **insertion** → *sclera*

→ *passing under inferior rectus & inserts on sclera*

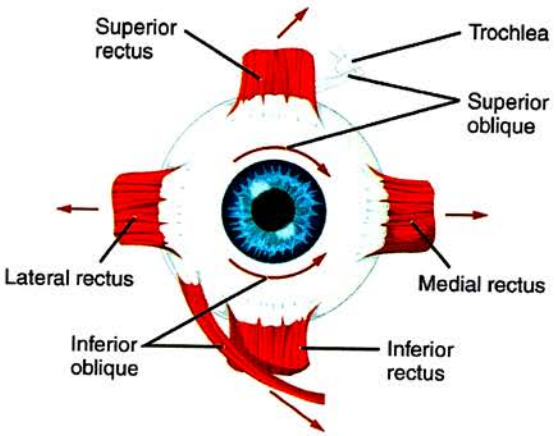
Recti muscles

Medial rectus → **adduction**

Lateral rectus → **abduction**

Superior rectus → **elevation**

Inferior rectus → **depression**



Anterior view of the right eye

Levator palpebrae superious

Skeletal part

→ *supplied by CN 3*

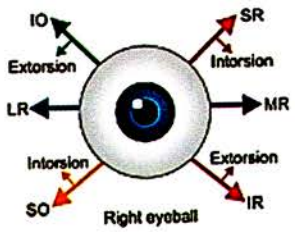
→ *injury leads to complete ptosis*

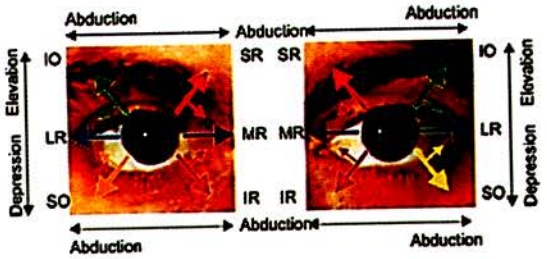
Muller muscle (superior tarsal muscle)

→ *smooth muscle*

→ elevates the eye lid
→ supplied by T1 sympathetic fibres
→ compromised in **horner syndrome (partial ptosis)**
SIN → only superior muscles can do intorsion
→ Superior muscles
Superior oblique
Superior rectus
→ Intorsion → **inward rotation**
→ **Superior rectus actions** → elevation, adduction, intorsion → **up, inside & intorsion**
→ **Superior oblique actions** → depression, abduction, intorsion → **down, out & intorsion**
Superior rectus & superior oblique are antagonistic **except for intorsion**

→ superior oblique muscle synergestic with
Superior rectus in intorsion
Lateral rectus in abduction





Superior oblique muscle

→ actions → **intorsion> depression > abduction**
→ copying muscle
→ **clinical testing → ask the patient to look at his tip of nose**
→ **in adducted eye**
strong depressor → SO
Weak depressor → IR

→ **In abducted eye**
Strong depressor → **inferior rectus**
Weak depressor → **superior oblique**
→ To check inferior rectus, ask the patient to **do depression in abducted eye**

→ superior rectus & superior oblique are antagonistics **except for intorsion**
→ superior oblique & inferior oblique are antagonistics **except for abduction**
→ superior rectus & inferior rectus are antagonistic **except for adduction**
both **obliques are abductors**
→ **all recti are adductors except lateral rectus (abductors)**

Ciliary ganglion

→ gives **short ciliary nerves & long ciliary nerves** inferior division of CN 3 is connected to ciliary ganglion & topographically connected to **trigeminal nerve** (post ganglionic fibres / short ciliary n) & supplies sphincter **papillae & ciliaris**

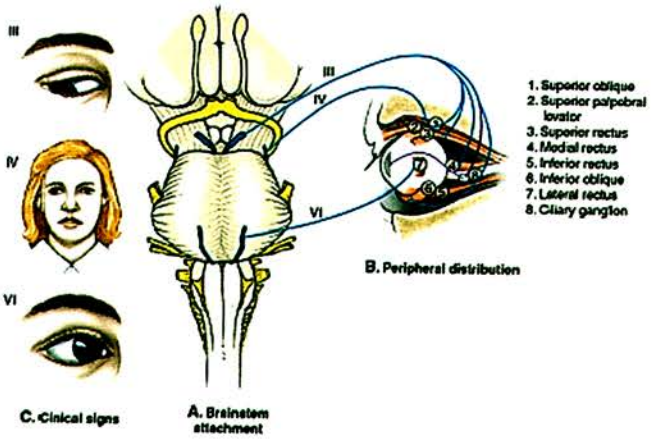
Long ciliary nerves

→ carries T1 sympathetic fibres from superior cervical ganglion & supplies dilator pupillae & superior tarsal muscles.

→ **compromised in horner syndrome**

Abducent nerve has longest intra dural course

Trochlear nerve has largest intra cranial course



Lesions

CN 3 → down & out eye

CN 4 → **head till opp. to side of lesion**

CN 6 → medial squint

Occulo-motor nerve (CN 3)

Course

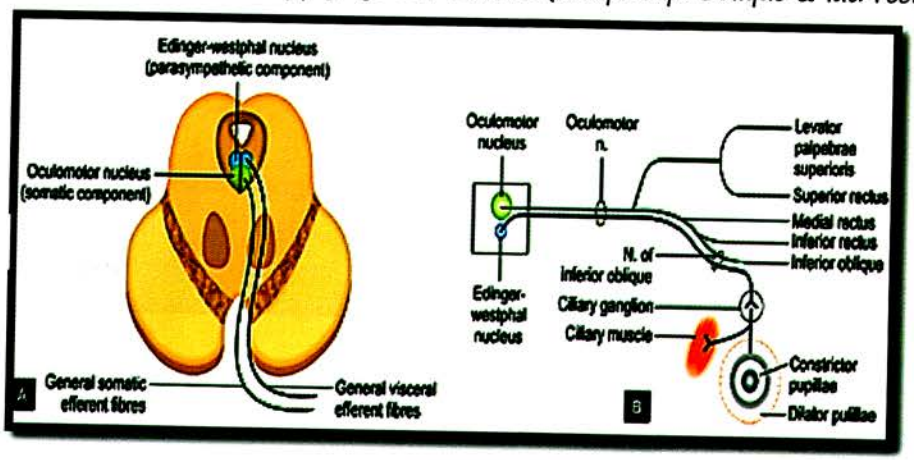
→ comes from midbrain **at the level of superior colliculus (periaqueductal grey)**

→ **passes b/w superior cerebellar & post. cerebral arteries**

→ becomes content of cavernous sinus (lateral wall)

→ exits through **superior orbital fissure (2 divisions)**

→ **reaches orbit & supply eye ball muscles (except sup. Oblique & lat. rectus)**



Edinger-westphal nucleus

→ para sympathetic component

→ controls sphincter pupillae (light refelex)
Ciliaris (accommodation reflex)

→ GVE

→ **sends pre ganglionic fibres to ciliary ganglion & post ganglionic fibres carried by br. of trigeminal nerve & supply sphincter pupillae and ciliaris**

Occulomotor nucleus

→ somatic components

→ controls all skeletal muscles of EB **except superior oblique & lat. rectus**

→ GSE

→ occulomotor nerve has sup & inf. Division in common tendinous ring of zinn & passes SOF

→ **inferior division is related to ciliary ganglion & supply inf. Rectus**

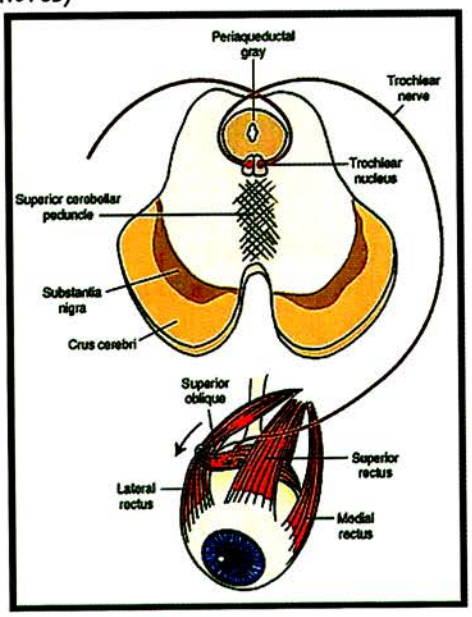
Rt CN 3 lesion

1. Down & out eye → **CN 4 & 6 are unopposed**
2. Ptosis → **LPS compromised**
3. Fixed & dilated pupil → **dilator pupillae unopposed (T1 symp, fibres)**

Trochlear nerve course

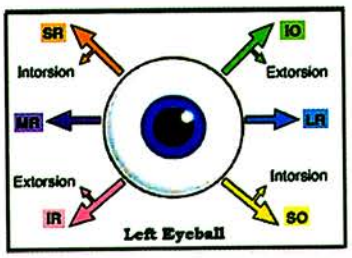
Thinnest /smallest /slimmest CN → very few axons
Longest intra cranial course
Only nerve with **dorsal exit**
Internal decussation + **nt (in mid brain)**
Course

→ trochlear nucleus present at inferior colliculus level
→ trochlear nerve → only nerve with dorsal exit
→ passes b/w **post. Cerebellar & superior cerebral artery**
→ **becomes the content of cavernous sinus (lateral wall)**
→ passes SOF, left outside the **ring of zinn**
→ enters orbit & supplies superior oblique muscle
→ superior oblique hooks **under trochlea** under orbit



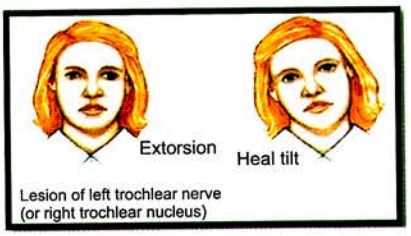
C/L innervation

→ rt trochlear nucleus gives it trochlear nerve & supplies it. Sup. Oblique
→ lt trochlear nucleus **gives Rt trochlear nerve & supplies Rt. Sup oblique**
→ In lt trochlear nerve injury → **Lt superior oblique is paralysed**
→ In rt trochlear nucleus injury → **Lt superior oblique is paralysed**
→ **Internal decussation** occurs at **superior medullary velum** at the roof of IV ventricle behind the brain stem



Trochlear lesion

→ superior oblique muscle affected → **vertical diplopia, while reading**
→ C/L head tilting **(to counteract extorsion)**



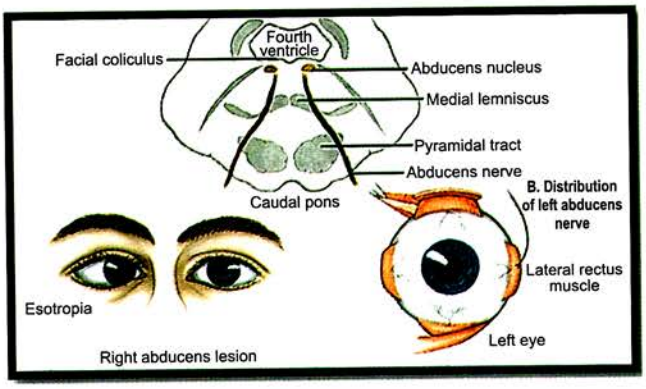
Abducent Nerve (Cn6)

Course

- Comes from pons
- Infero-**lateral to ICA running** through the cavernous sinus
- Passes inside the ring of zinn through **superior orbital fissure** and **supply the lateral rectus muscle**

Right CNS lesion

- Rt. Lateral rectus paralysis.
- Medial rectus unopposed **Medial Squint**



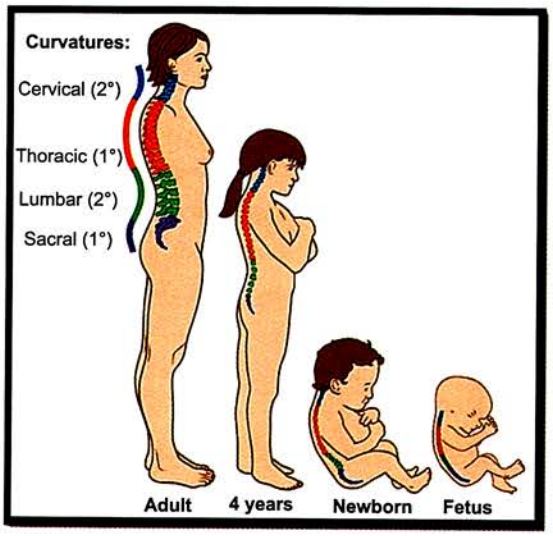
Back

Curvatures

Primary /Fetal curvature

→ Universal attitude of flexion

→ 1st degree primary → **Thoracic sacral**
Concave anteriorly
Convex posteriorly (**Kyphosis**)



Secondary curvatures

→ At 2 month (holding of neck) → **cervical Lordosis** +nt

→ at 1 yr, lumbar lordosis +nt (lordosis –ant. convexity)

→ Cervical Lordosis is d/t → neck holding

→ **Lumbar Lordosis is d/t → Sitting, standing, walking**

→ **During pregnancy → Exaggerated lumbar lordosis**

Similarities between Cervical and Thoracic vertebrae

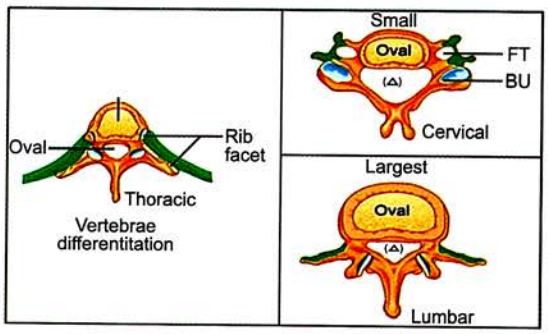
Body

→ Large & oval → Lumbar vertebra

→ Small & oval → cervical vertebra

→ Heart shaped
Thoracic vertebra

→ Triangular



Vertebral canal

→ Oval → Thoracic vertebra

→ Triangular → Lumbar & cervical

Transverse process

→ Foramen transversarium → present in cervical vertebra
→ **for the passage of vertebral artery**

→ Costal /Rib facet → present in thoracic vertebra

Inter vertebral disc → Fibro cartilage, acts as shock absorber

Spine → directed posteriorly

Blunt → lumbar

Inter vertebral foramen → for the passage of spinal nerves from spinal cord

Superior articular facet direction

Cervical vertebra → Backward, upward

Thoracic vertebra → backward, upward, lateral

Lumbar vertebra → Medial

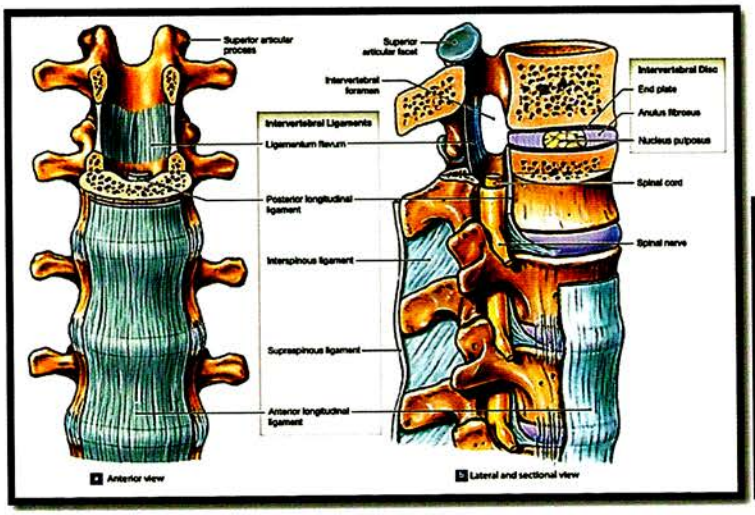
Foramen transversarium

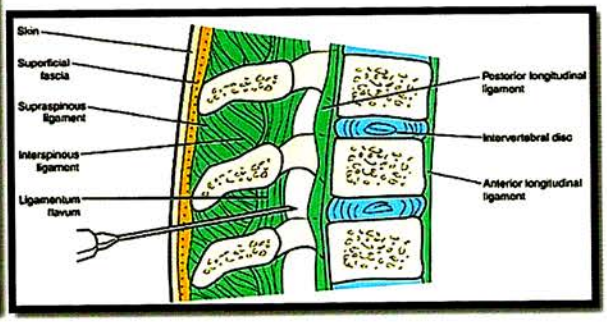
→ Present in transverse process of cervical vertebra

→ Vertebral artery pass through it

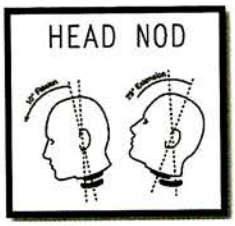
→ C1-C6 vertebra carries vertebral artery, but not C7

Ligaments and Spinal Cord





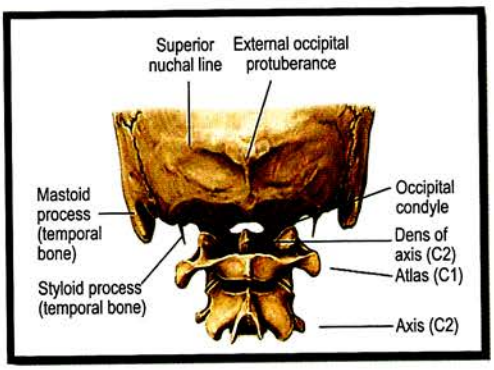
- → **Lumbar puncture for CSF aspiration is done at L4 vertebral vicinity**
- → L3-L4 or
- → L4-L5 (better option)



Cranio vertebral joints

Atlas (c-1) vertebra

- → Atlas vertebra don't have body
- → **Atlanto-occipital joint**
- → for **head nodding**
- → **ellipsoid synovial / condylar joint**
- → Vertebral artery comes from **foramen transversarium** & arches over superior surface of atlas vertebra (posterior arch) & enters cranial cavity by passing through **foramen magnum** upwards

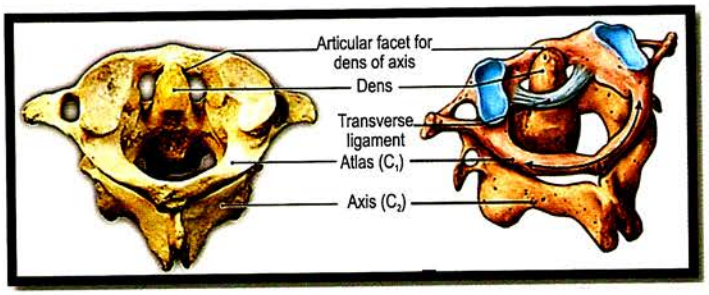


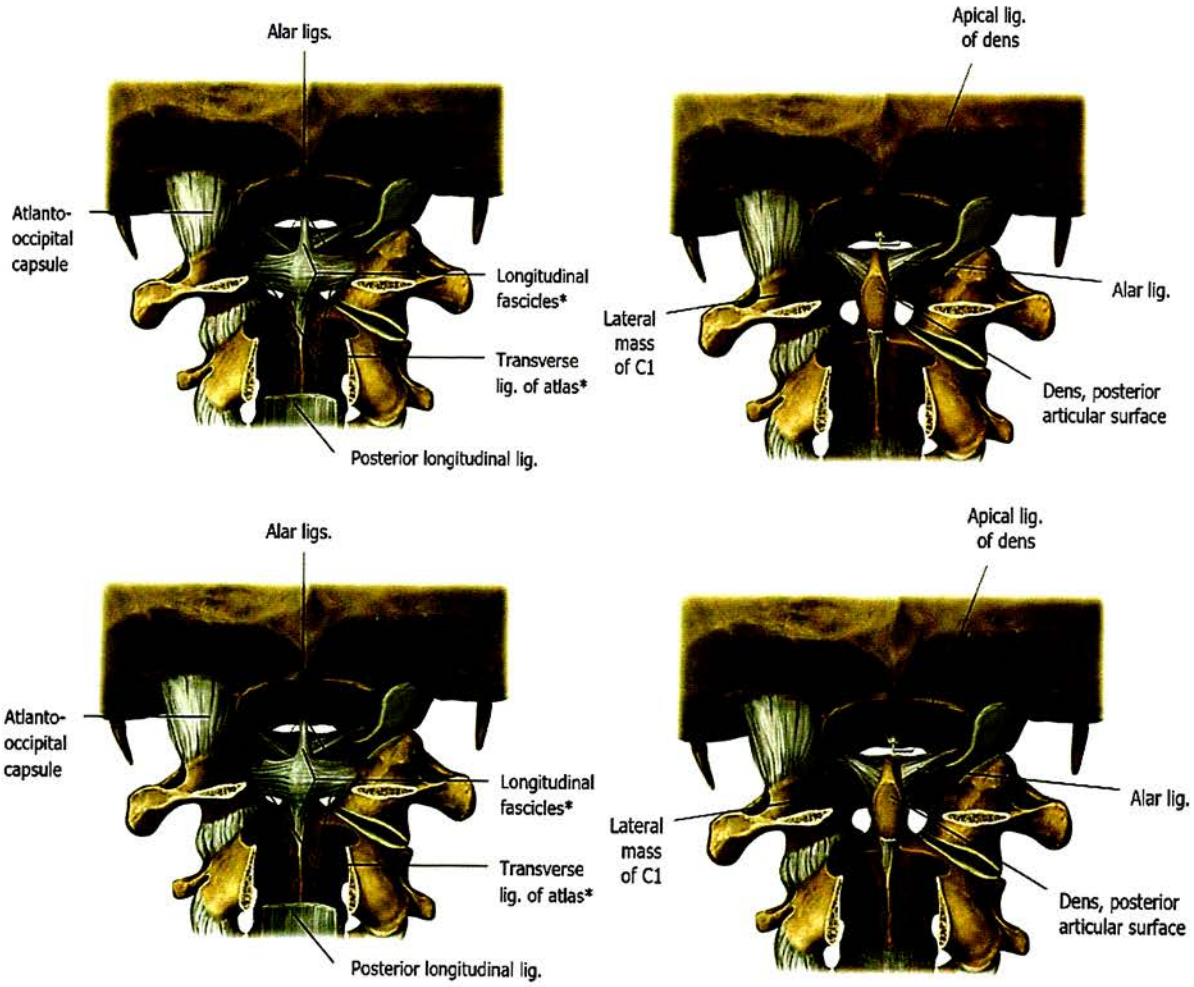
Axis vertebra

- → **Odontoid process / dens of axis**
- → body of C1 vertebra fusing with body C-2
- → goes to ant. arch of atlas & held by transverse ligament of C-1

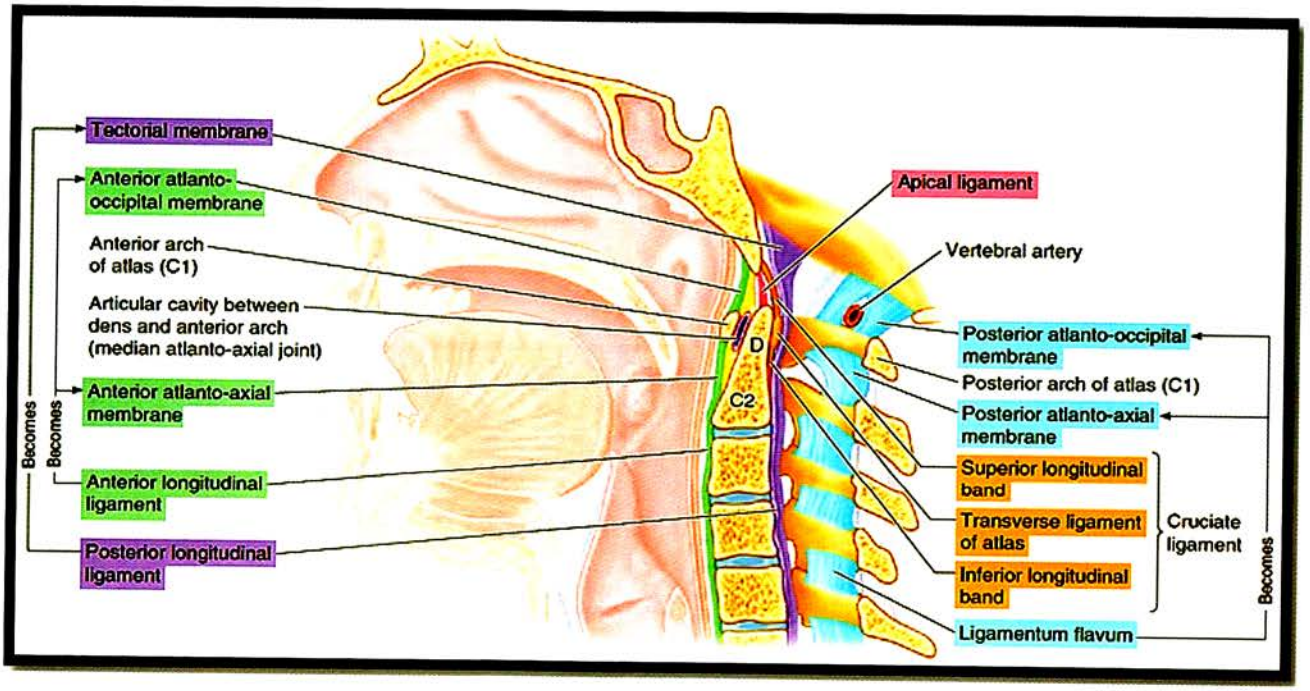
Atlanto- axial joint

- → Rotatory joint
- → Trochoid / pivot joint
- → Skull & atlas became 1 unit and rotates on axis joint

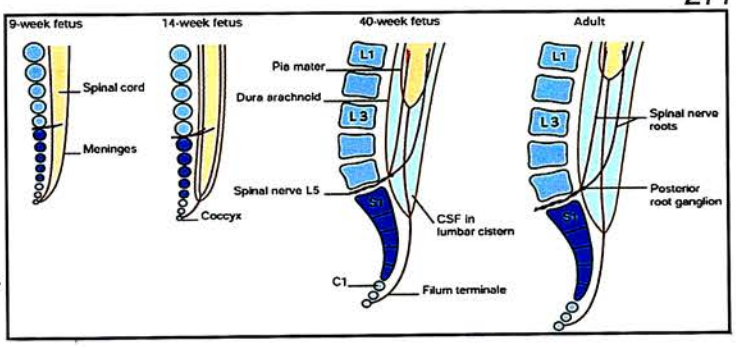




Side view of head and neck region



Spinal cord Termination



Stages of spinal cord termination

Early fetal stage

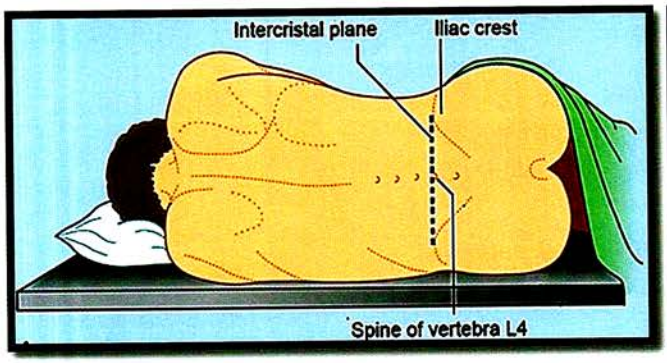
- → Length of spinal cord= length of vertebral column
- → spinal cord fuse with coccyx bone
- → relative faster growth of vertebral column
- → vertebral column attains → 60 cm
  Spinal cord attains → 45 cm

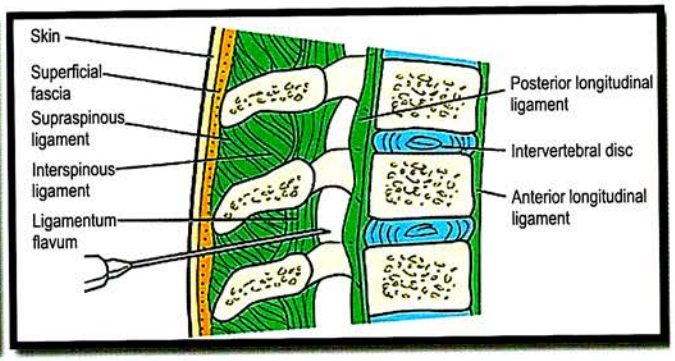
At birth

- → Spinal cord level is at → **upper border of L3 vertebra**
- → coccyx bone attaches spinal cord with filum terminale (collagen fibres)

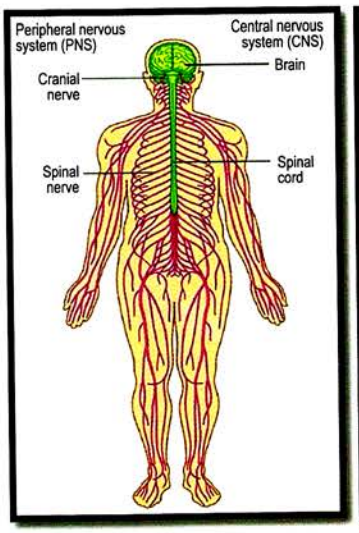
Adult level

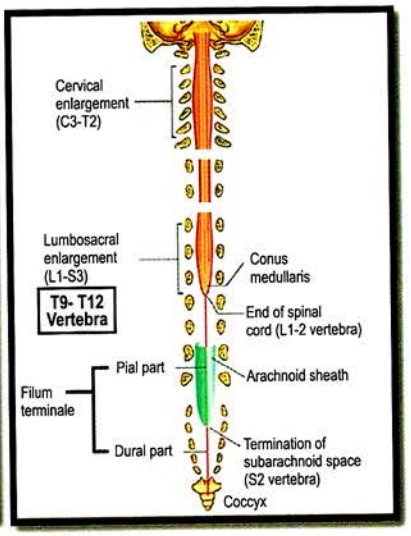
- → Transpyloric plane → **lower border of L1**
- → <2 yrs after birth, it reaches adult level





Enlargement & spaces





Enlargements

Cervical enlargement

- → collection of neural bodies that gives brachial plexus
- → Root value
  Brachial plexus → C5 – T1
  Cervical enlargement → C3 – T2

Lumbosacral enlargement

- → Root value
  Lumbosacral enlargement → $L_1 - S_3$
  Sciatic nerve → $L_4 - S_3$
- → Vertebrae surrounding LSE → $T_9 - T_{12}$

FilumTerminale

- → Collagen fibres connecting tip of spinal cord with coccyx
- → **PIAL part** → present above S_2, longer, covered by pia mater
  Dural Part → present below S_2, shorter, covered by both pia & duramater

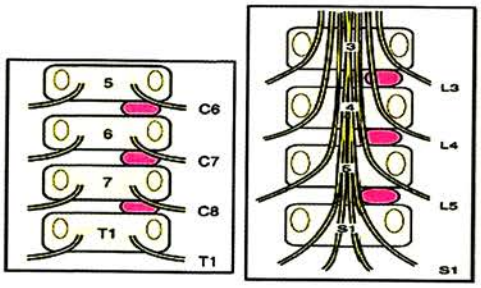
Termination of subarachnoid space is at → **lower border of S2 vertebra**

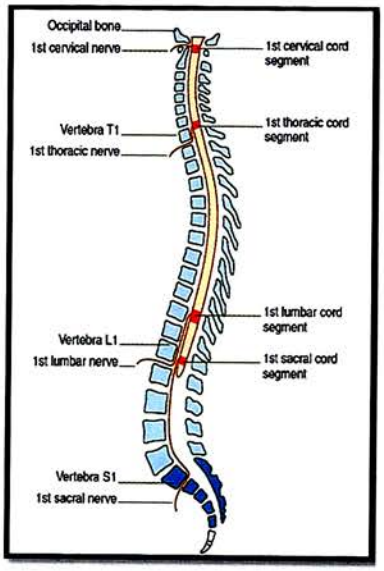
Spinal Nerves

→ **In cervical region.** Each spinal nerve reach superior to corresponding vertebra

→ **In cervicothoracci region,** each spinal nerve passes below corresponding vertebra

→ **In thoracic & lumbar region,** each spinal nerve passes below corresponding vertebra





Trick → Go to upper vertebra & add 1 (next nerve) Slip disc, usually Cx (10%) or Lumbosacral (90%)

→ Nerves are **short & straight in cervical region**

→ Nerves are **long & oblique** in Thoracic lumbar region

→ In slip disc in **cervical region,** corresponding nerve is involved

→ In slip disc in **thoraco lumbar region, next nerve** below is involved

SLIP disc b/w L4 & L5

→ L4 root not involved (postero lateral herniation of nucleus pulposus)

→ L5 nerve involved

Slip Disc b/w L5 & S1

→ L_5 nerve not involved

→ S_1 nerve involved

Slip disc b/w L5 & S1

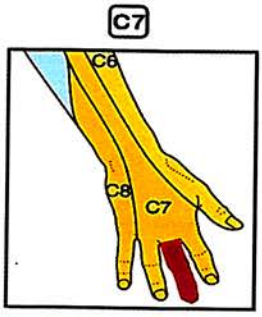
→ L5 nerve not involved

→ S1 nerve involved

Case 1

Burning sensation in middle finger (C7 dermatome) Triceps reflex is weak (C7 myotome)

→ Slip Disc → **C-6 & C-7**

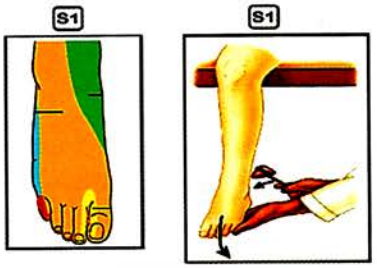


Herniated Disc between	Compressed Nerve Root	Dermatome Affected	Muscles Affected	Movement Weakness	Nerve and Reflex Involved
C6 and C7	C7	C7 Middle finger	Triceps Wrist extensors	Extension of for arm Extension of wrist	Radial nerve ↓triceps jerk

Case 2

Burning sensation in little toe (S1 dermatome) lateral margin ankle reflex is weak (S1 myotome)

→ Slip Disc → **L-5 & S-1**



Herniated Disc between	Compressed Nerve Root	Dermatome Affected	Muscles Affected	Movement Weakness	Nerve and Reflex Involved
L5 and S1	S1	S1 Heel Little toe	Gastrocnemius Soleus	Plantar flexion of ankle(patient cannot stand on toes) Flexion of toes	Tibial nerve ↓ankle jerk

Vertebral landmarks triangle

Scapula

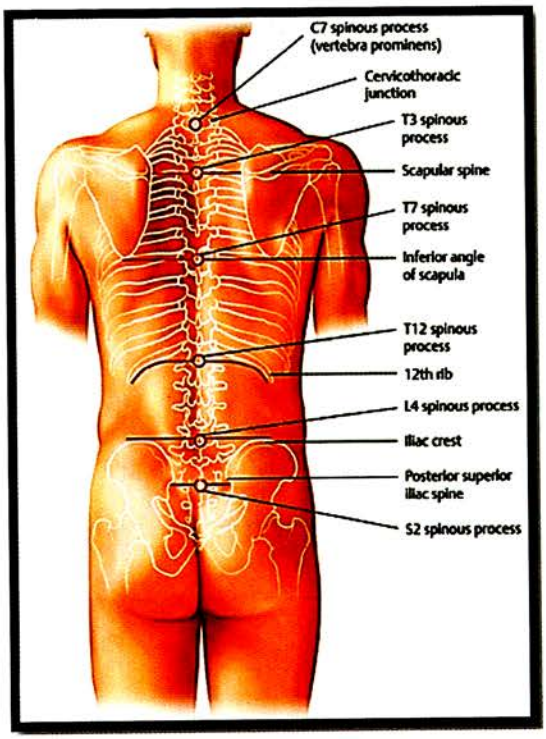
Superior angle → T-2

Spine → T-3

Inferior angle → T-7

Iliac bone

→ highest point of iliac crest → **L-4 spine**



Triangles

Triangle of auscultation

Boundaries

Medial border of scapula → lateral

Trapezius (triangular muscle) → superomedial

Lattissimusdorsi → Inferior

Rhmboid major → floor

Sounds of peristalsis of stomach
Sounds of lower lobes of lungs } **Listened here**

Lower lumbar /Petit's triangle

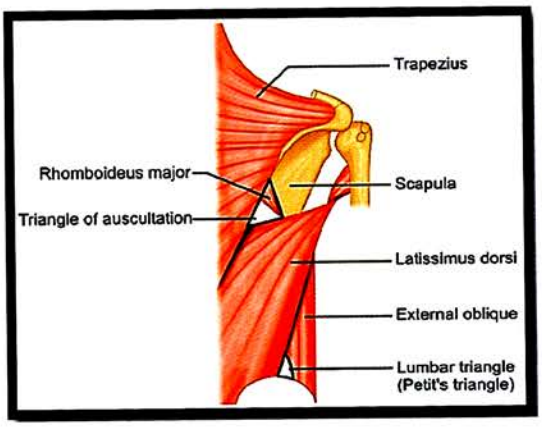
Boundaries

Latissimus dorsi → posterior

Iliac crest of hip bone → base

External oblique muscle → anterior

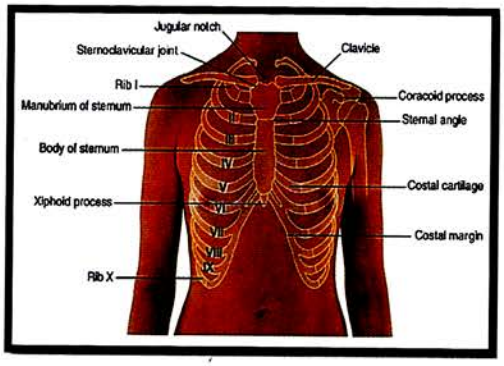
Deficiency of thick muscular coat here, prone to hernias.

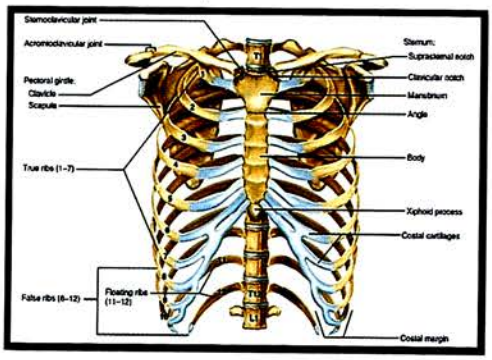


Thorax

Joints

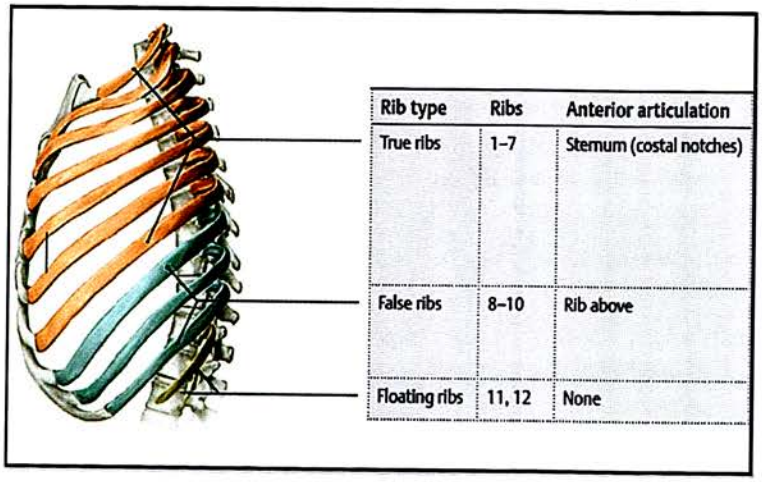
- → **True Ribs** → attaches to sternum directly Ribs – 1,2,3,4,5,6,7
  Came from vertebral → vertebra sternal ribs
- → **False ribs** → attaches to sternum indirectly with costal margin
  Costal margin – made by Rib 8,9,10 – vertebro-chondral ribs
- → Floating ribs → don't attach to sternum
  → ribs 11,12





Embryonic veins

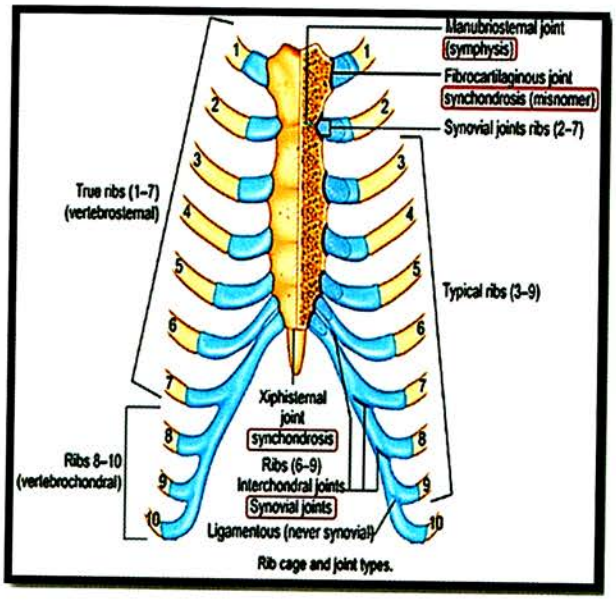
Placenta → umbilical veins → degenerate
Yolk sac → vitelline veins → portal vein
Body wall → cardinal veins → SVC & IVC
→ SVC & IVC are present on right side. Lt. side regressed



Rib type	Ribs	Anterior articulation
True ribs	1–7	Sternum (costal notches)
False ribs	8–10	Rib above
Floating ribs	11, 12	None

Joints in Thorax

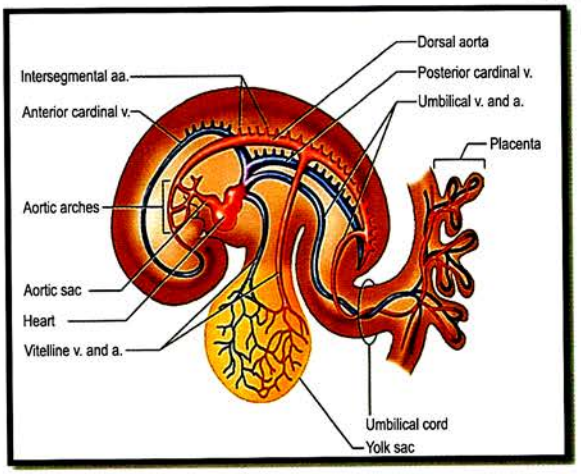
Ribs 3-9= Typical ribs
Ribs 10-12 = Atypical ribs
Except joints at ribs 1 and 10, all are synovial joints (required for free/ breathing movements)
At rib 10 - fibrous joint
At rib 12- synchondrosis
Xipthisternal- synchondrosis



Vitelline veins

Vitelline vein
→ Derived from yolk sac
→ Forms portal vein
- Major contribution from right vitelline vein

- Minor contribution from left vitelline vein
- Anastomosis b/w left & right vitelline vein
- Portal vein present towards right side.
- → Rest of vitelline vein regresses

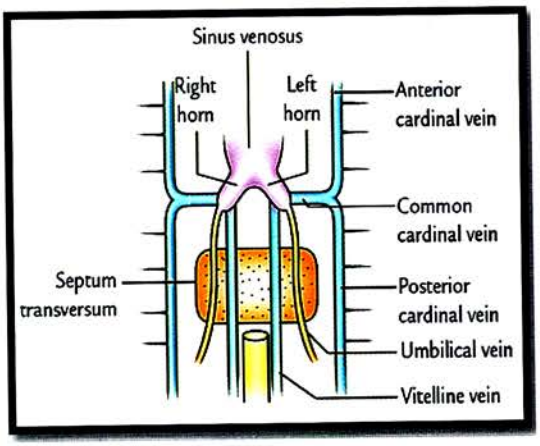


Cardinal veins

- → Ant. cardinal vein contributed to superior vena cava Post cardinal vein contributed to IVC (partly)
- → Left ant & left post. cardinal veins regress

Common cardinal veins, Vitelline veins and Umbilical veins drain blood into two horns of sinus venosus. Anterior cardinal veins(ACV) and posterior cardinal veins(PCV) receive blood from body above the diaphragm and from body below the diaphragm respectively.

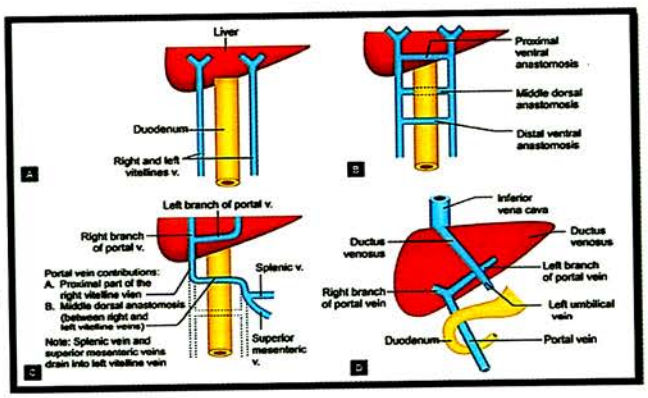
Both ACV and PCV join to form common cardinal vein
ACV and PCV join contribute to SVC and IVC respectively, on right Side only and not on the left side (regresses).



Rt. umbilical vein regresses and Lt. umbilical veins degenerate To form ligamentum teres. They drain the blood from placenta into left. and right horns of the heart tubes.

Rt. And LT Vitelline veins pass through septum transversum. Septum transversum divides the vitelline veins into rt. And Lt. hepatic channels.
Rt. Sided hepaticocardiac channel form terminal part of IVC (carries blood from limbs to heart).
Rt. Vitelline vein(major contribution) with left vitelline vein (minor contribution) forms IVC
Vitelline veins drain yolk sac which forms gut tube.

Yolk sac forms the gut tube.
Portal vein formed by major contribution from Rt. Vitelline vein and the anastomosis between the Rt and lt vitelline veins and minor from left vitelline vein.



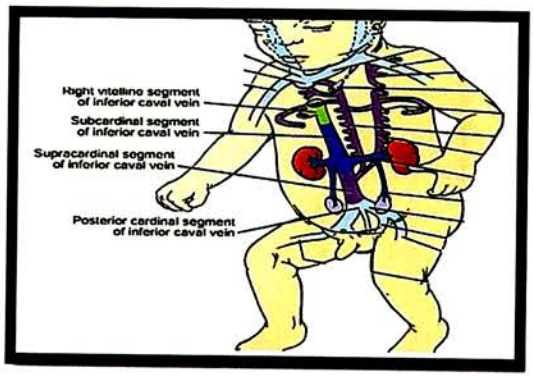
Portal vein passes behind the 1st part of duodenum to form lt and rt portal vein inside the liver.
Lt portal vein is connected to IVC by Ductus Venosus to bypass liver as liver is immature to filter the deoxygenated blood carried by left umbilical vein.

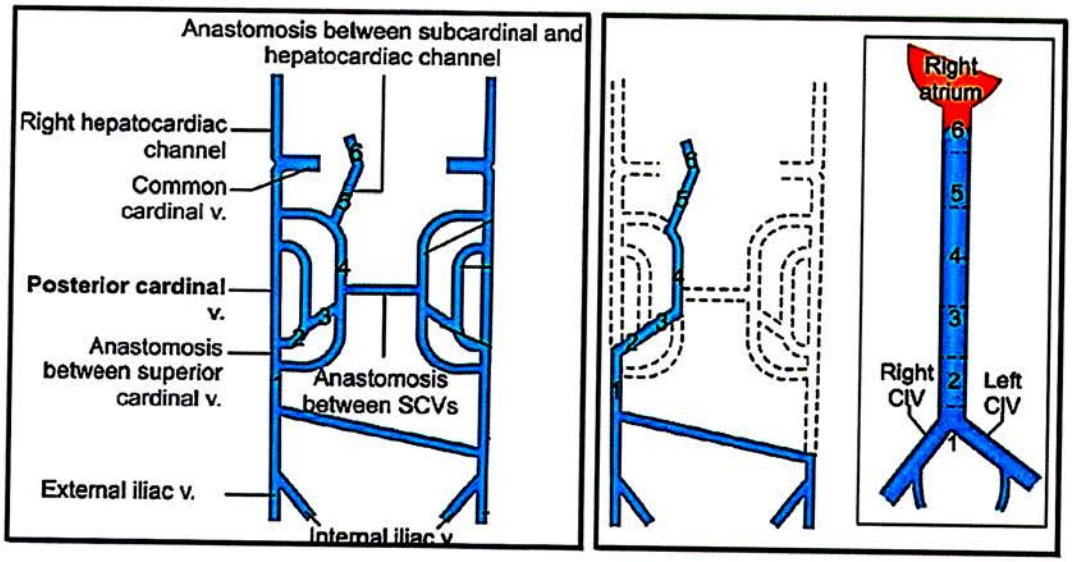
Embryonic	Adult
Vitelline veins	
Right and left	Portion of the IVC,[a] hepatic veins and sinusoids, ductus venosus, portal vein, inferior mesenteric vein, superior mesenteric vein, splenic vein
Umbilical veins	
Right	Degenerates early in fetal life
Left	Ligamentum teres
Cardinal veins	
Anterior	SVC, internal jugular veins
Posterior	Portion of IVC, common iliac veins
Subcardinal	Portion of IVC, renal veins, gonadal veins
Supracardinal	Portion of IVC, intercostal veins, hemiazygos vein, azygos vein

Inferior vena cava contributed by

1. *Rt. Vitelline vein (hepatic portion)*
2. *Post. cardinal vein (beginning of IVC)*
3. *Sub cardinal vein (renal & supra renal portion)*
4. *Supra cardinal vein (infra renal portion)*

Note- Remember all these veins are Rt. Sided because IVC is on right side and left sided veins regresses.

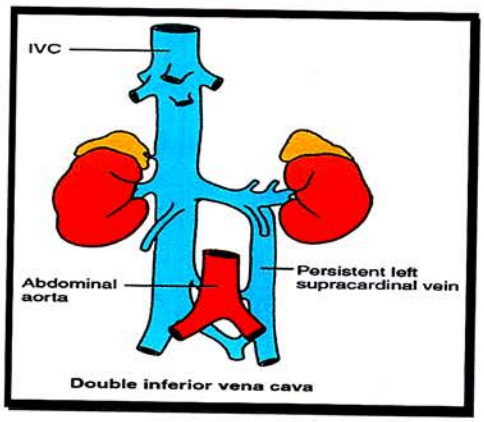




Double IVC

Persistence of lt sided IVC

Infra renal portion persistence (lt supra cardinal vein)



Heart tube

5 parts

1. Sinus venosus → smooth inflow tract
2. Primitive atrium — **rough trabeculated portion of 4 chambers**
3. Primitive ventricle
4. Bulbus cords → smooth outflow tract
5. Truncus arteriosus

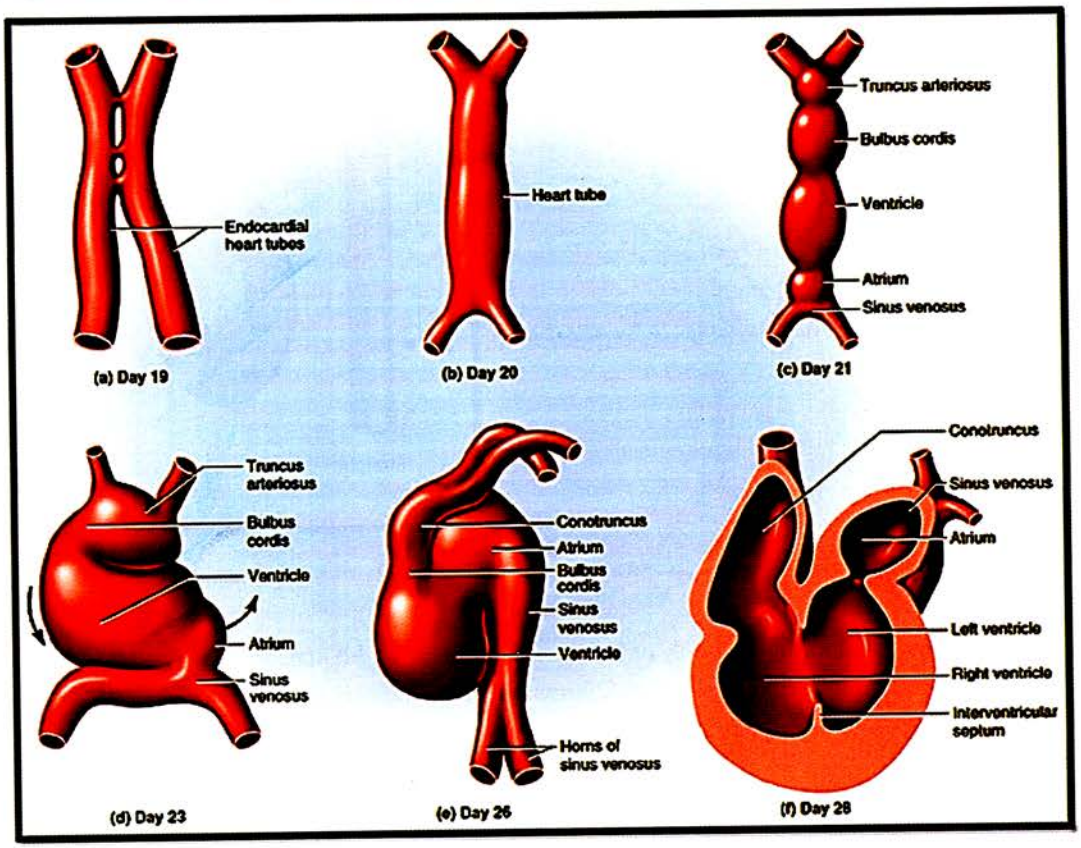
Sinus venous

→ Contain right & left horns

→ Receives venous blood from 3 set of veins

Ant. cardinal vein } Common
Post cardinal vein }

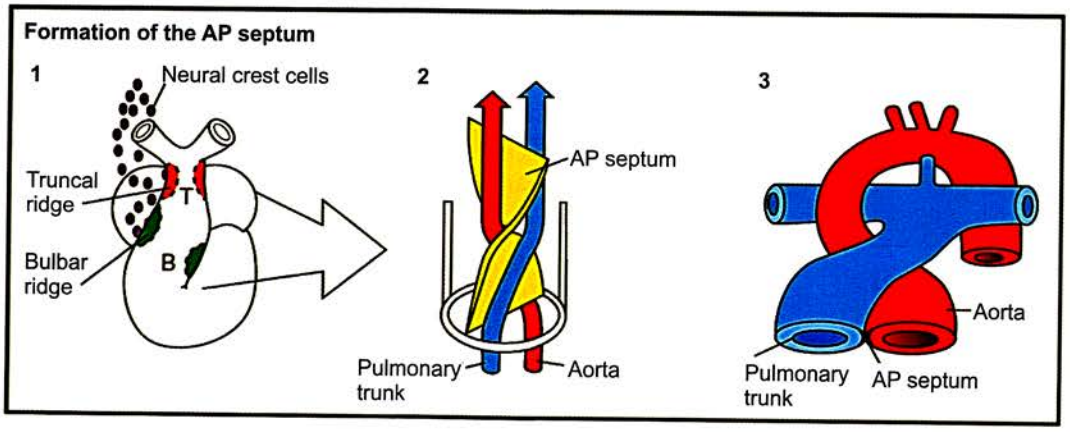
Embryonic dilatation	Adult derivatives
Truncus arteriosus	Ascending aorta Pulmonary trunk
Bulbus cordis	Smooth upper part of the right ventricle (conus arteriosus) Smooth upper part of the left ventricle (aortic vestibule)
Primitive ventricle	Trabeculated part of the right ventricle Trabeculated part of the left ventricle
Sinus venosus	Smooth part of the right atrium (sinus venarum) Coronary sinus Oblique vein of the left atrium



AP septum (aorta pulmonary septum)

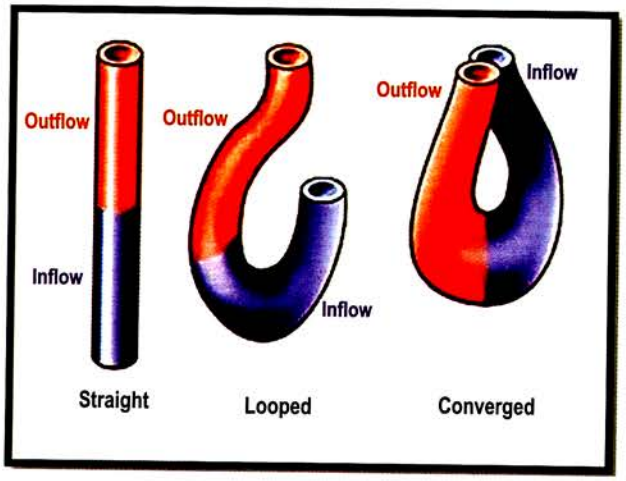
- → **Derived from Neural Crest cells**
- → Divides TA into ascending aorta & pulmonary septum
- → Ascending aorta contributes to systemic circulation
- → Pulmonary aorta contributes to systemic circulation
- → Spiral septum
  - → **Ascending aorta → pulmonary trunk interchanges position**
  - → RA → RV → pulmonary trunk → pulmonary circulation
  - LA → LV → Ascending aorta → systemic circulation

- → **Transposition of great vessels**
- → Straight AP septum
  - **RA → RV → Asc. Aorta → systemic circulation**
  - **LA → LV → Pulm.. Trunk → pulm circulation**



Folding of heart tube

- → Upper arterial end comes anterior
- → Lower venous end goes posterior
- → Transverse pericardial sinus → space b/w the two.

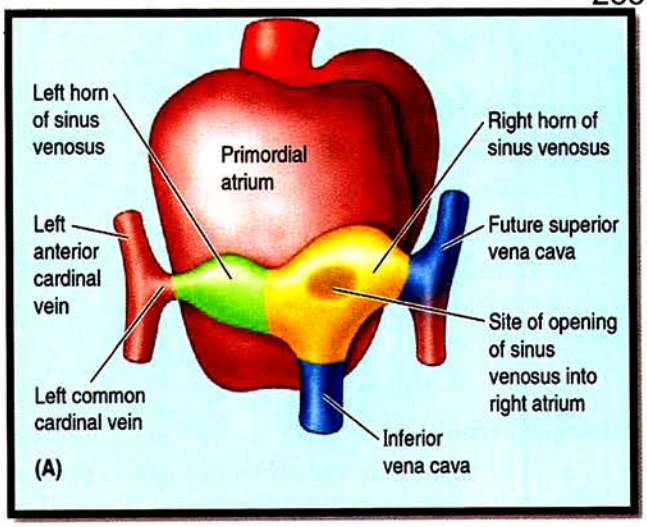


Sulcus terminalis → boundary line b/w rough with smooth part of right atrium from outside
Crista terminalis → boundary line b/w rough with smooth part of right atrium from inside
→ SA node develops at upper end of crista terminalis in sub-epicardial region> myocardium

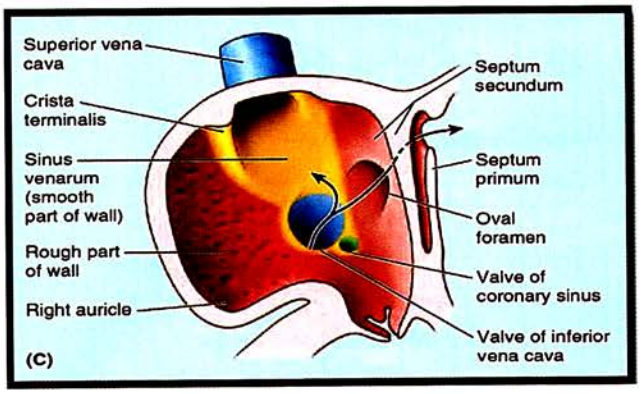
Coronary sinus → receives venous blood from heart & drains into post wall of RA

Post wall of RA /sinus venarum (Smooth Portion)

→ veins opening here
Coronary sinus
Post cardinal vein → IVC
Ant. cardinal vein → svc



Ant wall of RA: Shows pectinate muscles lying anteriorly, COMES FROM PRIMITIVE ATRIUM.

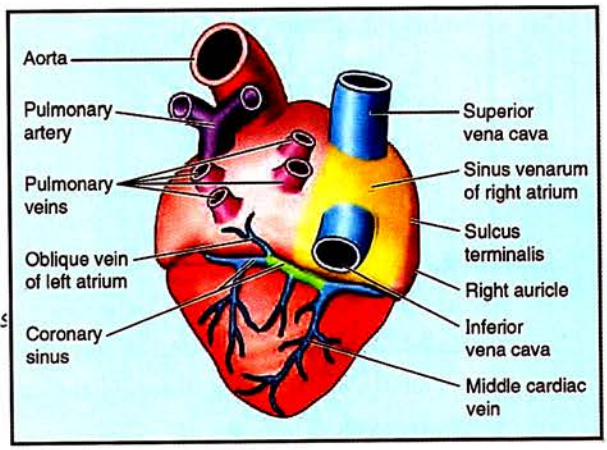


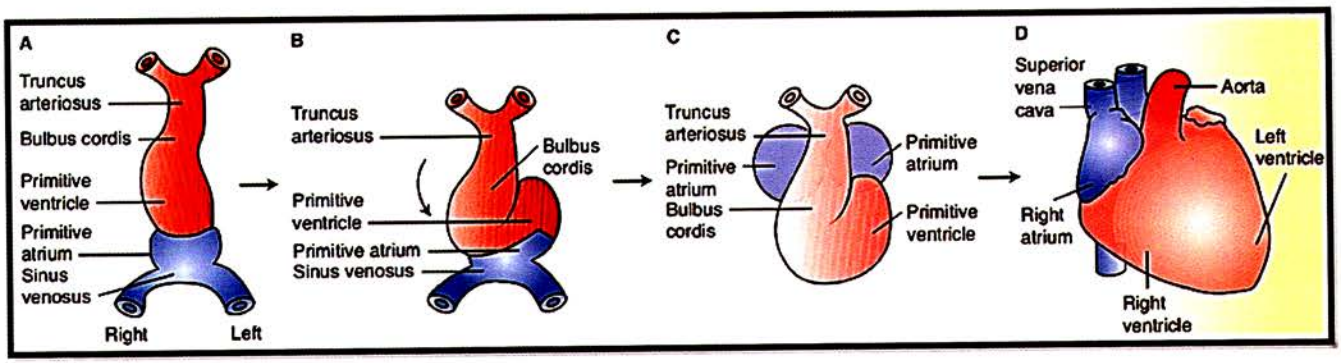
Post wall of LA

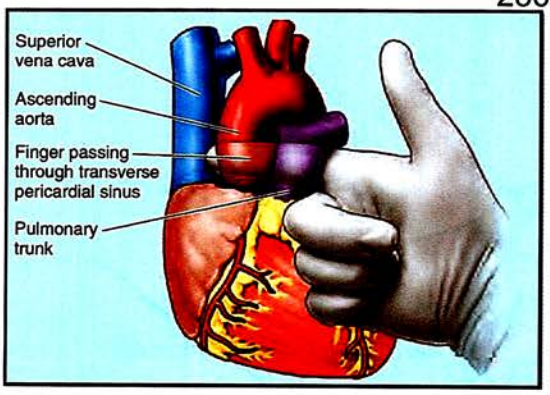
→ 4 pulmonary veins opens here → contributed by the partial absorption of 4 pulmonary veins

1 pulmonary vein → 4 pulmonary vein → post. wall of LA

→ Lt atrial wall → 1 pulmonary veins → 4 pulmonary veins







Transverse pericardial sinus

Cardiac looping / folding

→ Upper arterial end comes anterior

→ Lower venous end goes posterior

→ Transverse pericardial sinus present b/w the two fingers

→ TA – Ascending aorta

Pulmonary trunk

Pulm. Artery & ductus arteriosus comes from 6th pharyngeal arch artery

→ In heart lung machine surgery

Pull ascending aorta & pulmonary trunk anterior with finger placing in transverse pericardial sinus

SVC present behind the finger

Atrio ventricular cushion

Forms → Tricuspid valve on right side

→ Mitral valve on left side

Septum primum fuses with AV cushion

Foramen primum

→ Present in septum primum

→ Blood from RA to LA passes through this initially

→ Gradually it disappears

Foramen secundum

→ Present in septum primum

→ Now blood from RA passes LA through foramen secundum

Septum secundum

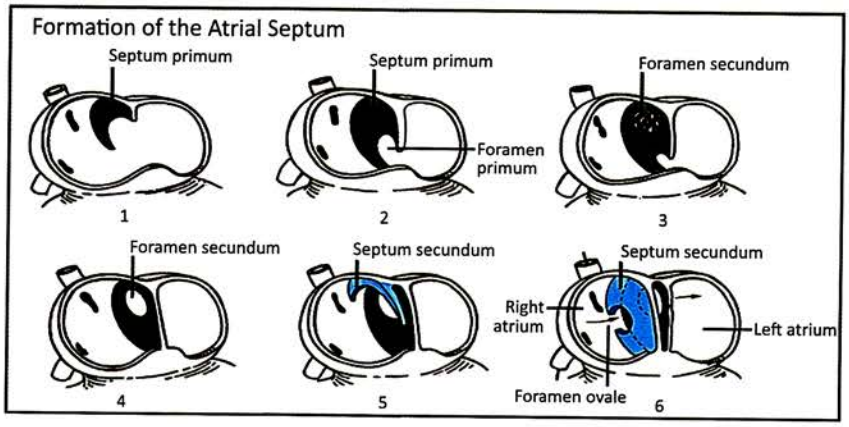
→ Present right side of septum primum

→ Contains foramen ovale, for the passage of blood from RA to LA

→ Now blood from RA passes an oblique course (from foramen ovale to foramen secundum) to reach LA

→ Foramen ovale is inferior

→ Foramen secundum is superior



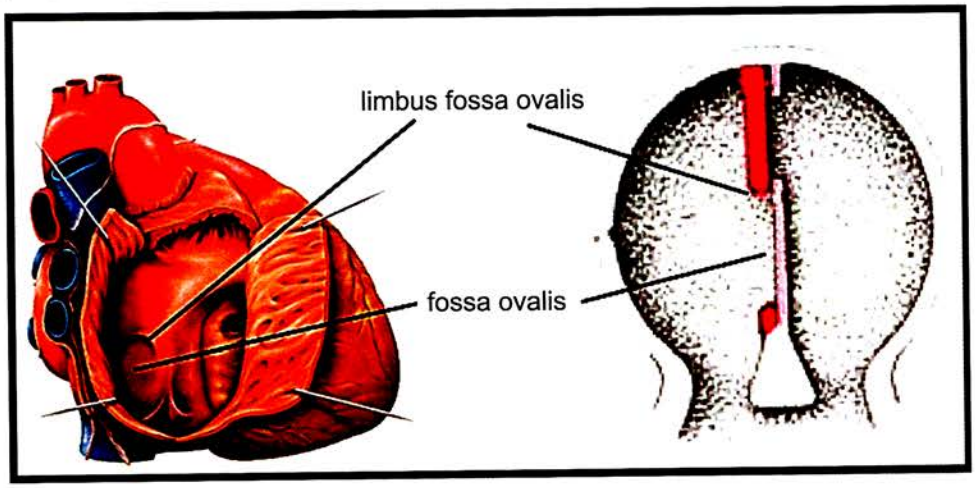
After birth

→ LA pressure is high
→ Two septa will fuse
→ Foramen ovale fuses with septum primum & close
→ Foramen secundum fuses with septum & close
→ Fossa ovalis → vestigial remnant of foramen ovale
→ Septum primum seen on floor on left side

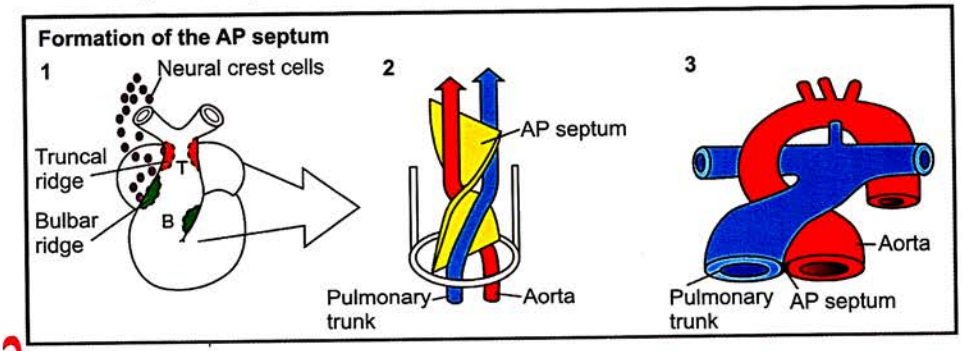
Limbus fossa ovalis → Thickened margin on foramen ovale
→ Present right side inter atrial septum
→ Comes from septum secundum

TRIANGLE OF KOCH:

- Formed by septal cusp of tricuspid valve, tendon of Todaro (Collection of subendocardial collagen fibres), AV node lies here.
- In AV nodal Re - entry tachycardia, RFA of AV node is done at triangle of TODARO.
- AP septum formation & anomalies

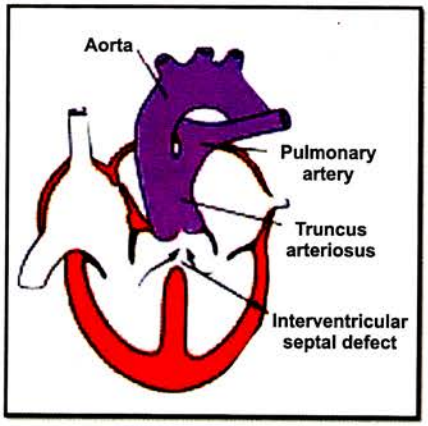


Formation of AP septum: derived from neural crest cells. These cells migrate towards truncus arteriosus to form cono truncal ridges, & form AP septum. It is spiral in shape. Malformation of this septum lead to Persistence of truncus arteriosus, failure to rotate spirally can lead to TGA, TOF can occur: Ant vessel becomes narrow leading to pulmonary stenosis & post vessel becomes large leading to over-riding of aorta.



- Persisting truncus arteriosus
- Transposition of great vessels
- Tetralogy of fallot

congenital cyanotic heart disease



Cyanotic Heart Disease

a) Rt. → Lt. shunt
b) Pulm. → systemic Circulation → circulation
c) Congenital → present since birth

Aorto pulmonary septum formation:

→ Neural Crest Cells comes towards TA region & develop truncal /conotruncal ridges Ridges will grows & fuses with each other forming septum separating TA into ascending aorta (posterior), pulmonary trunk (posterior)
→ AP septum is spiral septum

AP septum anomalies (All are cyanotic heart disease)

Persisting truncus arteriosus (PTA)

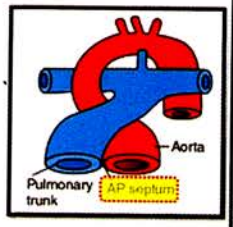
→ Absence of migration of NCCs to TA region / absence of NCCs → No AP septum
→ Truncus arteriosus persists
→ No ascending aorta & no pulmonary trunk
→ Mixing of blood occurs → cyanosis
→ AP septum absent

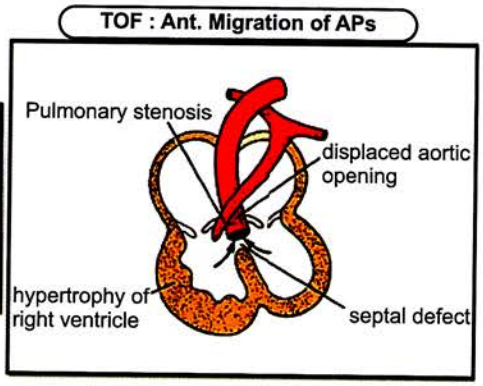
Transposition of great vessels (TGA)

→ AP septum is not spiral
→ Vessels are straight & opens into opp. chambers
Rt ventricle → Ascending aorta
Lt ventricle → Pulmonary trunk } Cyanosis
→ Babies do not survive
→ PDA (patent ductus arteriosus) is essential requirement for survival
→ ASD & VSD also develop as compensatory mechanisms

TOF (Tetralogy of fallot)

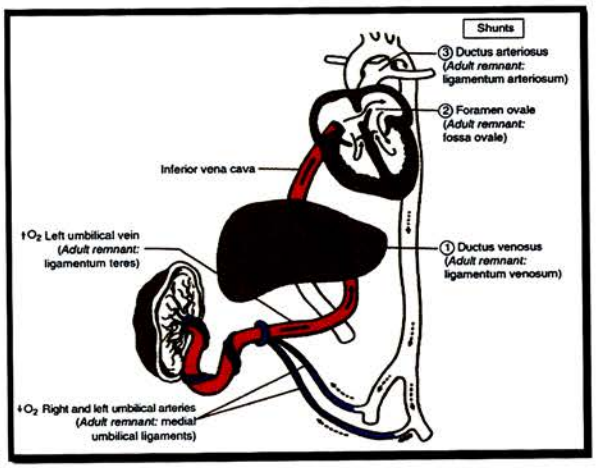
→ Ant. migration of AP septum
→ causes pulmonary stenosis
→ Aorta becomes larger & over rides inter ventricular septum
→ VSD present in membranous part
→ Rt ventricular hypertrophy occurs d/t Sending blood into narrow vessels (pulm. Trunk) Asc. Aorta (high pressure)
→ Rt. ventricle is 3 times thicker than Lt ventricle





Note:- Pentalogy of fallot → TOF + ASD

Fetoplacental circulation



Umbilical cord

- → contains 2 umbilical arteries & 2 umbilical veins initially
- → Rt umbilical vein regress & Lt umbilical vein left
- → Umbilical arteries carries deoxygenated blood
- → Umbilical vein carries oxygenated blood
- → Ductus venosus, takes oxygenated blood & bypasses Liver & passes to IVC & Rt. atrium of fetus
- → RA blood bypasses lung & sends blood to LA through foramen ovale
- → some blood in Rt. ventricle, sends to pulmonary trunk
- → Pulmonary trunk bypasses lungs by ductus arteriosus & sends blood to ascending aorta
- → deoxygenated blood in fetus collects into aorta into iliac artery Iliac artery sends blood to Rt. & Lt. umbilical arteries

After birth

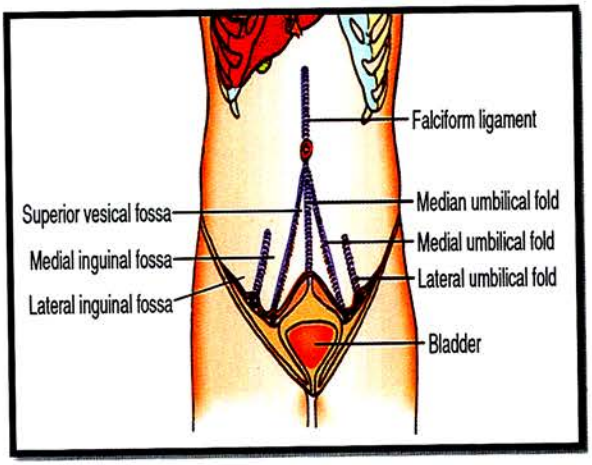
- → **Lt umbilical vein** → obliterated & forms **Ligamentum teres**
- → **Ductus venosus** → closed & becomes **Ligamentum venosum**
- → **Foramen ovale** → Closed & becomes **fossa ovalis**
- → **Ductus arteriosus** → Physiological closure (immediate vasospasm after birth)
  Anatomical closure (d/t tunica intima proliferation & fibrosis)
  a) Vasospasm occurs in 1-4 days
  b) If it is >96 hrs, Rx. by prostaglandins
  Anatomical closure completed in 1-3 months if >12 weeks, Rt. by Sx repair
- → **Umbilical arteries** → **Medial umbilical ligaments**

Peritoneal folds

- → On Ant. abdominal wall

Falciform ligament

- → Double fold of peritoneum
- → coming from umbilicus region
- → Going towards liver
- → Carries Lt. umbilical vein in fetus towards liver carries ligamentum teres in adult towards liver



Medial umbilical fold → peritoneal fold on medial umbilical ligament

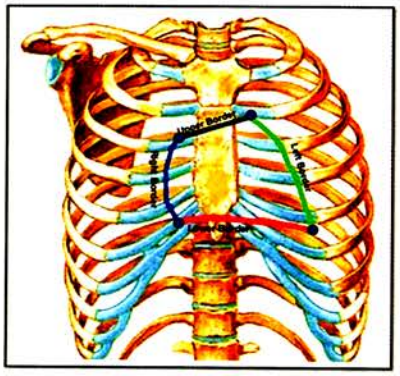
Lateral umbilical fold

- → Produced by inferior epigastric vessels running towards the rectus sheath & enters rectus sheath.

Median umbilical fold

- → One in midline
- → Covers allantois
- → Hind gut diverticulum attaching to tip of apex of urinary bladder in fetus
- → Contains lumen, which is obliterated to become urachus in adults

Surfaces and Grooves



Borders of Heart

Point 1 – Lower border of left costal cartilage
Point 2 – Upper border of costal cartilage
Point 3 - Right sided 6th costal cartilage
Point 4 – 5th left intercostal space.

Anterior sterno costal surface

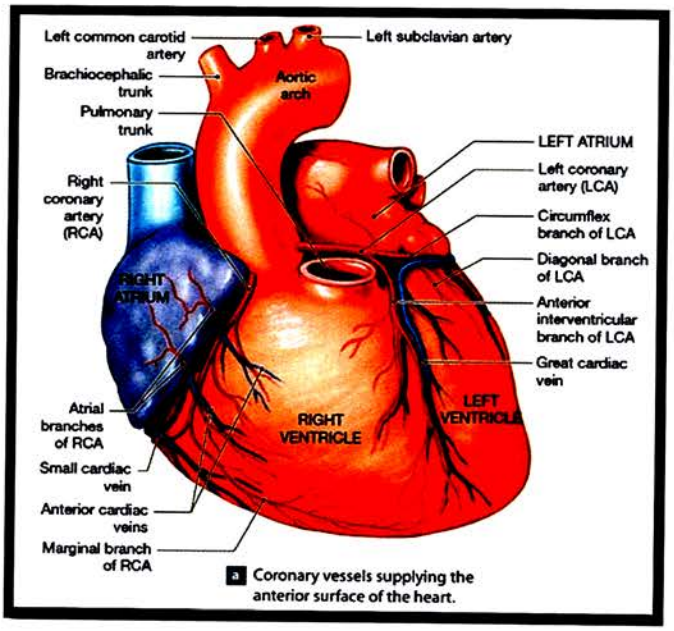
Contributors
1) Rt. ventricle (major contributor)
2) Rt. atrium
3) Lt. ventricle
4) Lt. auricle

Rt. coronary sulcus /RT AV groove

→ Contains Rt. Coronary artery (Br. of descending aorta)
→ Runs anteriorly & posteriorly
→ Small cardiac vein follows it posteriorly
→ Drains coronary sinus posteriorly

Inter ventricular septum /groove

→ Anterior ventricular artery
  → Present in anterior inter ventricular groove
  → Supplies ant. 2/3rd of IV septum
  → Greater cardiac vein
    - Forms at cardiac apex & accompany AIVA & runs posteriorly
    - Drains coronary sinus posteriorly

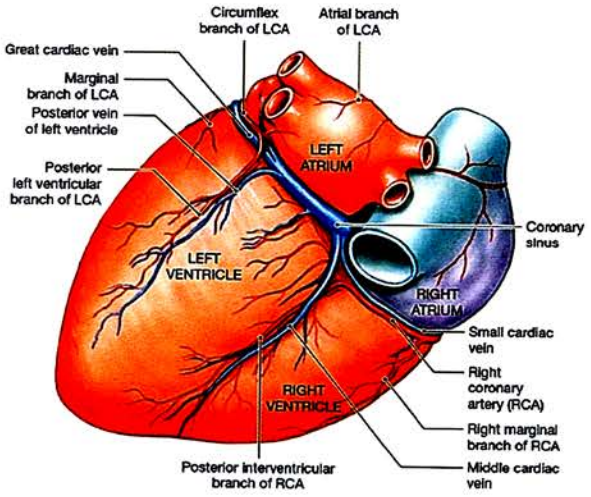


a Coronary vessels supplying the anterior surface of the heart.

Venous drainage

→ Small cardiac veins
→ Great cardiac vein
→ Middle cardiac vein

Drains into → coronary sinus → drains into → Post. wall of Rt. atrium



Anterior cardiac veins drains into → Ant. wall of Rt. Atrium

Great cardiac vein

Running in AIVG with AIVA anterior to the heart goes circumferentially around, goes behind the heart & drains left end of coronary sinus posteriorly

Small cardiac vein → Drains into coronary sinus posteriorly
→ Continuation of Rt. Marginal vein

Middle cardiac vein → Runs in PIVG with PIVA
→ Drains Into coronary sinus

Coronary sinus drains into post wall of Rt. Atrium

Posterior view

→ Coronary sinus in coronary sulcus posteriorly
→ Coronary sulcus / AV grove → separate atria & ventricles
Rt. atrium with SVC & IVC opening into it
Lt. atrium with pulmonary veins opens into it
→ Posterior surface / base of heart formed by
1) Rt. atrium (partly contributory)
2) Lt. atrium (major contribution)
Rt. ventricles & Lt. ventricles are sitting on diaphragm
→ Diaphragmatic surface

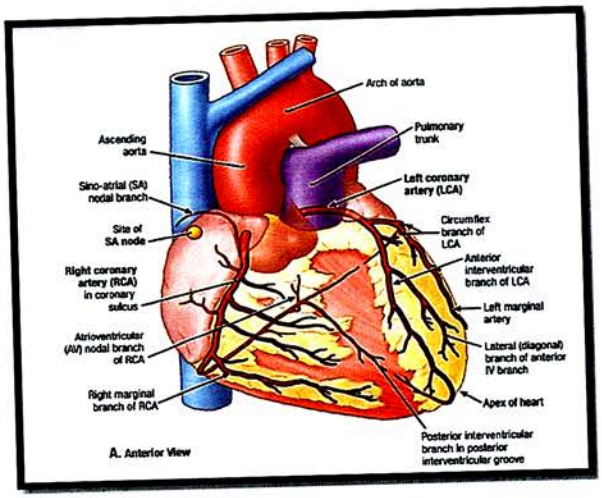
Posterior inter ventricular groove/septum

→ Contains posterior inter ventricular artery
→ Supplies post. 1/3rd of IV septum
→ Accompanied by middle cardiac vein
→ Drains coronary sinus

Coronary sinus → drains into post. wall of Rt. atrium along with SVC & IVC

2. Inferior view / diaphragmatic surface

- LV (mainly) + RV
- Post i/v grove with i/v septum & post i/v artery (branch of Rt. Coronary artery)
- Supplies post 1/3rd of inter ventricular septum
- Middle cardiac vein drain into posterior smooth part of Rt. Atrium.



Arterial supply

→ Br. of ascending aorta
→ Runs in right coronary sulcus anteriorly gives SA nodal artery
→ Runs in coronary sulcus posteriorly gives AV nodal artery & posterior inter ventricular artery
→ Cardiac dominance

Decided by PIVA

→ 65% has Rt. cardiac dominance (br. of Rt. coronary artery)
→ 10% has Lt. cardiac dominance (br. of circumflex artery)
→ 25% has co dominance (multiple PIVA, one from rt. Side & other from Lt side)

Lt coronary artery
Branches
Left anterior descending artery / AIVA (in AIVG)
→ Supplies ant. 2/3rd of IV septum

Circumflex artery
→ Continuation of Lt coronary artery
→ Goes circumferentially around & behind the heart in Lt. coronary sulcus

Inter ventricular septum
Posterior 1/3rd → PIVA (br. of Rt. coronary artery)
Anterior 2/3rd → AIVA (br. of Lt. coronary artery)

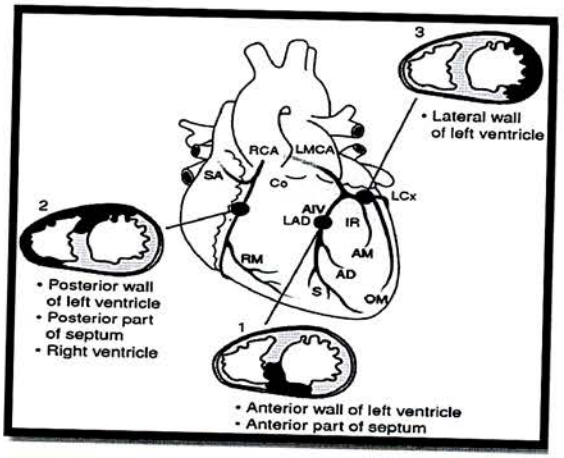
Left ventricle
Ant. wall → AIVA
Post. wall → PIVA
Lat wall → circumflex artery

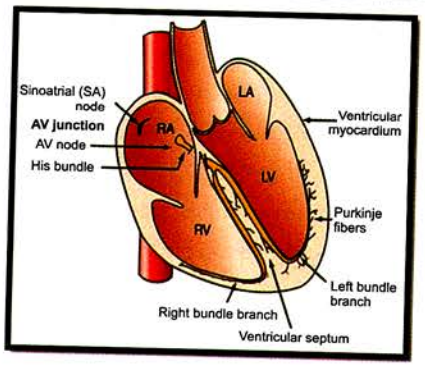
Rt coronary artery supply
Proximal conducting system
SA node
AV node

Lt coronary artery supply
Distal part of conducting system
→ AV bundle of HIS
→ Rt. Bundle branch
→ Lt. bundle branch

AV bundle of HIS
Present on IV septum
Supplied by
AIVA (major supply) – branch of LCA
PIVA (partly)

Triple vessel disease (relative incidence of vessels)
→ 50% → Lt ant. descending artery
→ 30% → RT coronary artery
→ 15% → circumflex artery

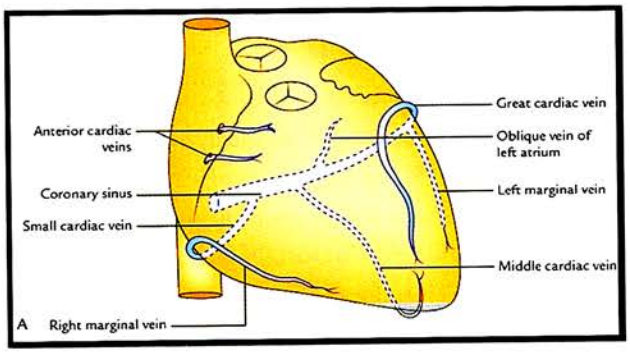




LAD block (Anterior i/V artery)
Ischemia of ant. wall of Rt. & left ventricle & also anterior 1/3rd of i/v septum
RCA block – Rt. chambers compromised.
Ischemia of post.1/3rd of i/V septum & also post wall of LV.

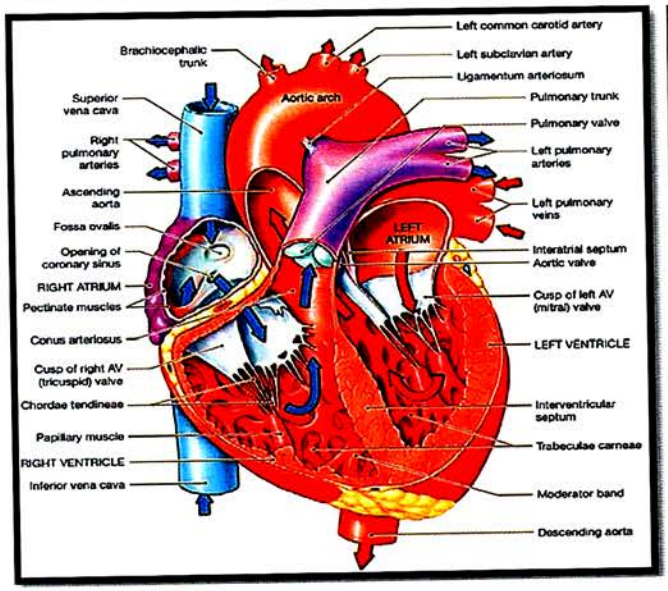
Circumflex artery block – lateral surface of LV
compromised anterior wall & posterior wall of LV
survives because of supply from AIVA & PIVA respectively.

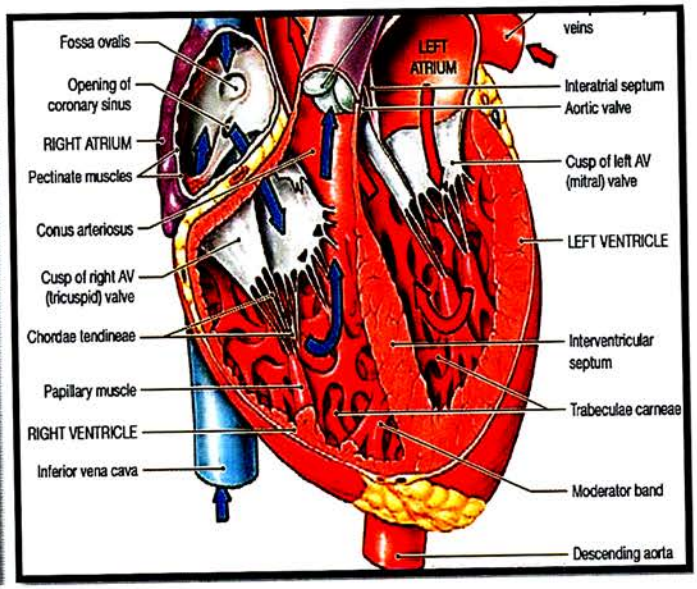
Venous drainage of heart:
All veins drain into Coronary sinus.
Rt. marginal vein becomes small cardinal vein, runs along right coronary sulcus & drain post into coronary sinus. Middle cardiac vein runs in post IV groove of heart, supplies post. Inter ventricular septum.



Great cardiac vein begins near apex of heart, ascends up along with ant IV artery in the AIV groove. Coronary sinus thrombosis causes dilation of all veins except Ant cardiac vein which drains directly into ant wall of RA. Whereas Coronary sinus drains into post wall of RA.

Blood flow through out heart





Body below diaphragm → IVC
Body above diaphragm → SVC
→ RA
Rt. AV value / Tricuspid checks
→ RV
→ Pulmonary trunk → Lungs → Pulmonary veins → Left atrium → Left ventricle → Aorta → Systemic circulation

Backflow in prevented by mitral value
With 2 cusps

Right atria

→ 3 openings in posterior smooth wall of atrium

1. SVC
2. IVC
3. Coronary sinus

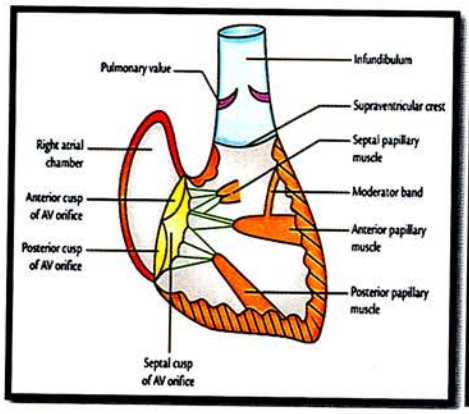
→ Blood flow from RA to RV & backflow of blood is checked by Rt. AV / tricuspid valve having 3 cusps

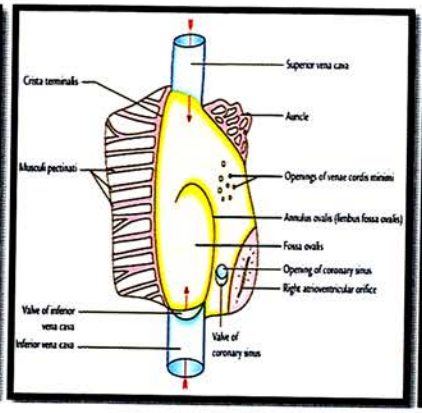
– **anterior, posterior & skeletal**, each cusp is attached to **papillary muscles** with the help of **chordate tendinae**. This attachment of muscle to cusps of valves makes it taut & prevents out ballooning of cusps towards RA & thereby, **preventing back flow** of blood.

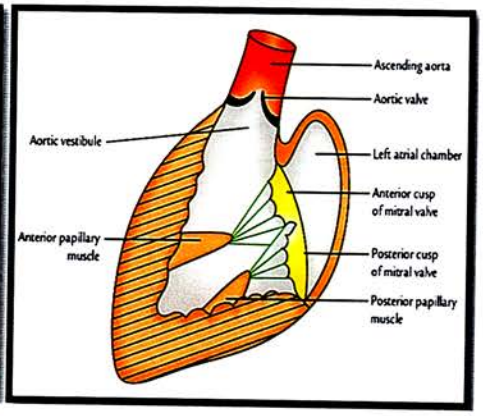
→ Anterior-papillary muscle have moderate or band K/A septo-marginal trabeculae

→ Inter-ventricular septum have thick & thin portion

→ Mitral valve prevents **back flow of Blood from LV to LA. therefore the blood should go towards aortic vestibule. Aortic vestibule is smooth outflow tract of left ventricle, embryologically derived from bulbous cordis.**







Anterior view of lung

	Right lung	Left lung
Lobes	Superior, middle, inferior	Superior, inferior
Fissures	Oblique, horizontal	Oblique
Bronchopulmonary segments	10	8-10
Unique features	Larger and heavier than the left, but shorter and wider due to higher right hemi-diaphragm	Superior lobe characterized by the lingual and a deep cardiac notch

Principal bronchus (First Degree bronchus)

Right principal bronchus (primary bronchus)

→ **Short** in length

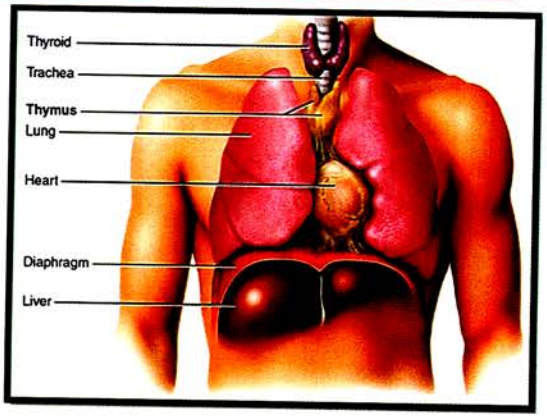
→ **Has wide lumen**

→ More vertical

→ Has more chances of FB lodging

→ **Angle b/w Rt. & Lt. principal bronchi – 70 degree**

→ Rt. PB has 3 lobar bronchi



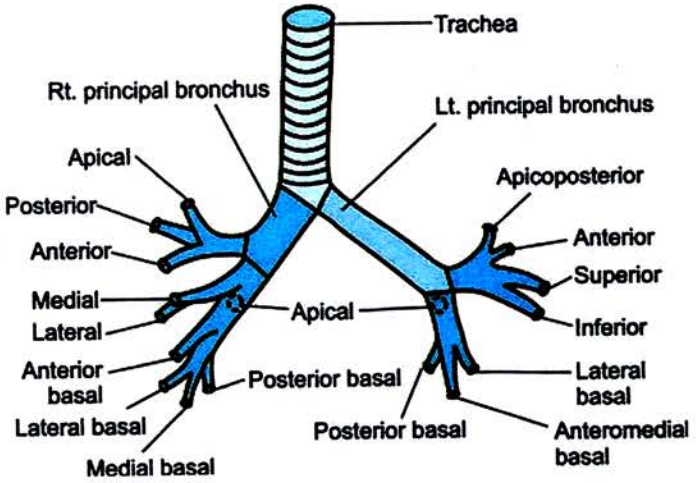
→ Second degree bronchus (lobar bronchus)

Upper lobe
Middle lobe
Lower lobe
} 3 second degree bronchus on Rt side

Left upper lobe
Left lower lobe
} 2 second degree bronchus on left side

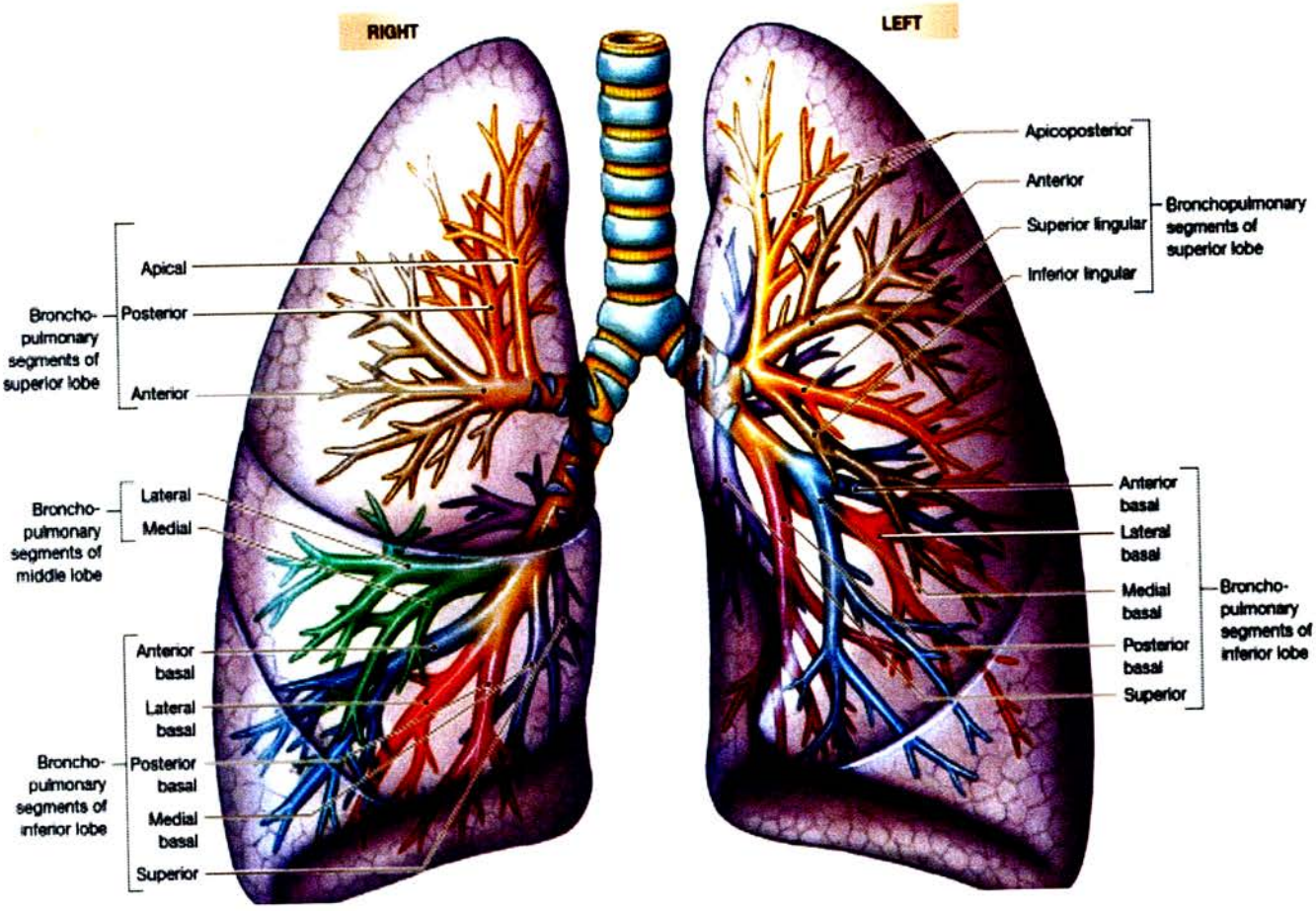
Tertiary bronchus – supplies one unit of the lung which is called as bronchopulmonary segment (BPS)

There are 10 BPS on Rt. & Left lung each.

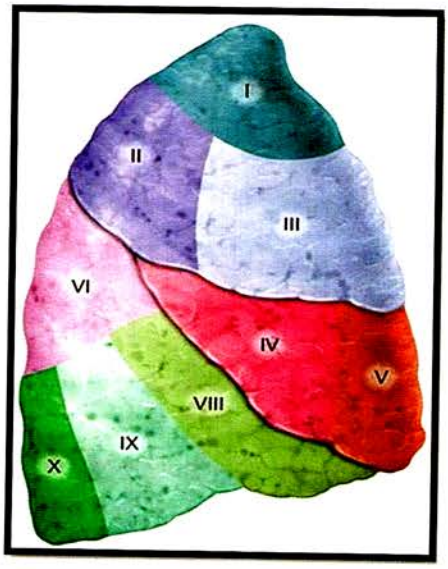


The bronchial tree

Broncho pulmonary segments

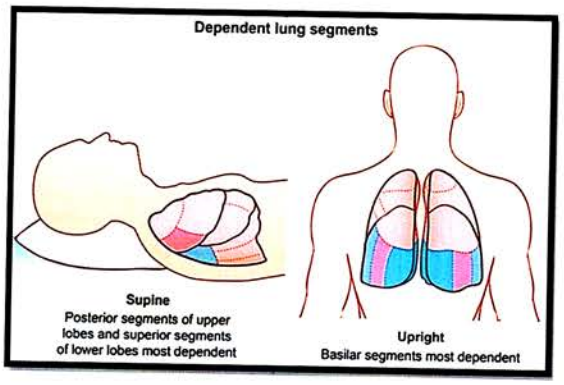


Right Lung	Left Lung
Right Upper Lobe	*Left Upper Lobe*
Apical segment	Apicoposterior segment
Anterior segment	Anterior segment
Posterior segment	Superior lingular segment
Right Middle Lobe	Inferior lingular segment
Medial segment	
Lateral segment	
Right Lower Lobe	*Left Lower Lobe*
Superior segment	Superior segment
Anterior basilar segment	Anteromedial basilar segment
Medial basilar segment	Lateral basilar segment
Posterior basilar segment	Posterior basilar segment
Lateral basilar segment	



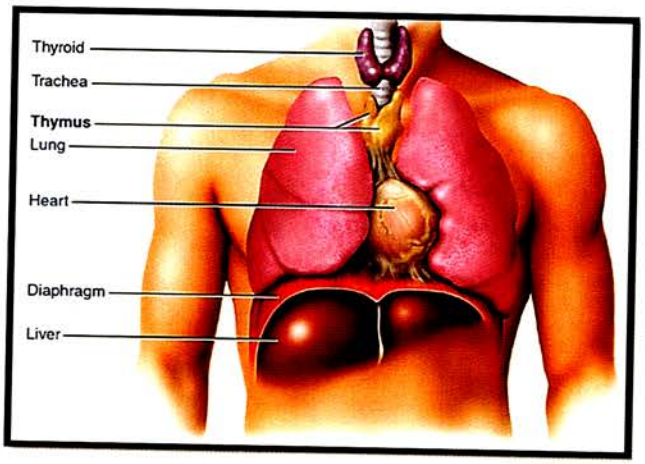
In dextrocardia (Situs inversus)

Medial basal of Rt. lower lobe is absent
Rt. lung has 9 BPS & Lt lung has 10 BPS (rare)
So, there can be 8,9,10 BPS, in left lungs
8 BPS → d/t fusion of apical posterior & anterior as Apico-posterior and fusion of anterior of medial basal as antero medial basal 9 BPS → but usually we have apical of posterior as separate and medial basal is missing



→ Most dependent location in erect sit/stand posture with aspiration pneumonitis

→ Most of aspiration occur in supine posture
→ B'Coz most patient are unconscious (coma or post anaesthetize patients)
→ Most dependent location → post BPS of Rt. upper lobe or Apical BPS of Rt. lobe **(better answers)**



- Medial basal is absent in left lung to accommodate heart

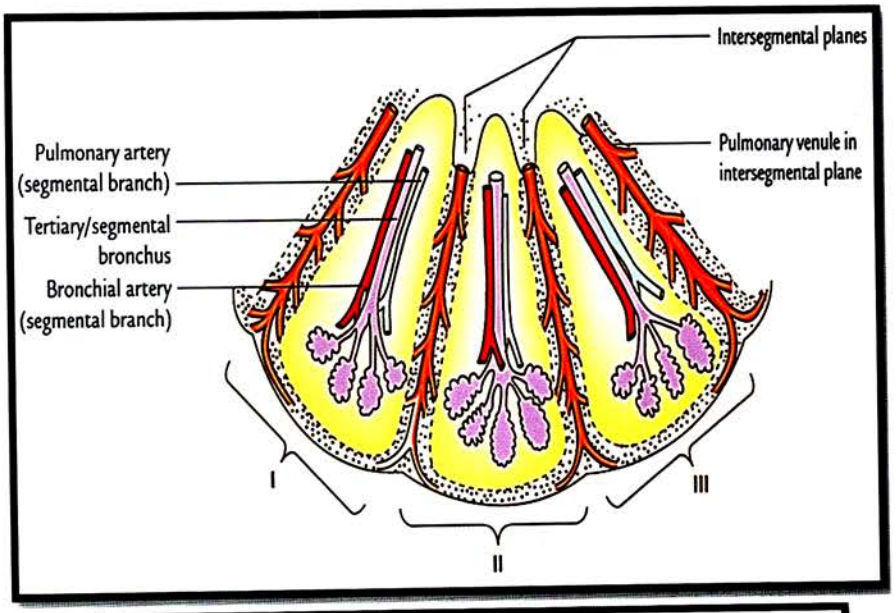
Broncho-pulmonary segments

→ Aerated by tertiary bronchus

→ No of BPS
Rt. lung → 10
Lt. lung → 8-10

Pulmonary vein branches
→ Intersegmental
→ Used for surgical planes

BPS inside structures
Pulmonary artery Branch
Bronchial artery

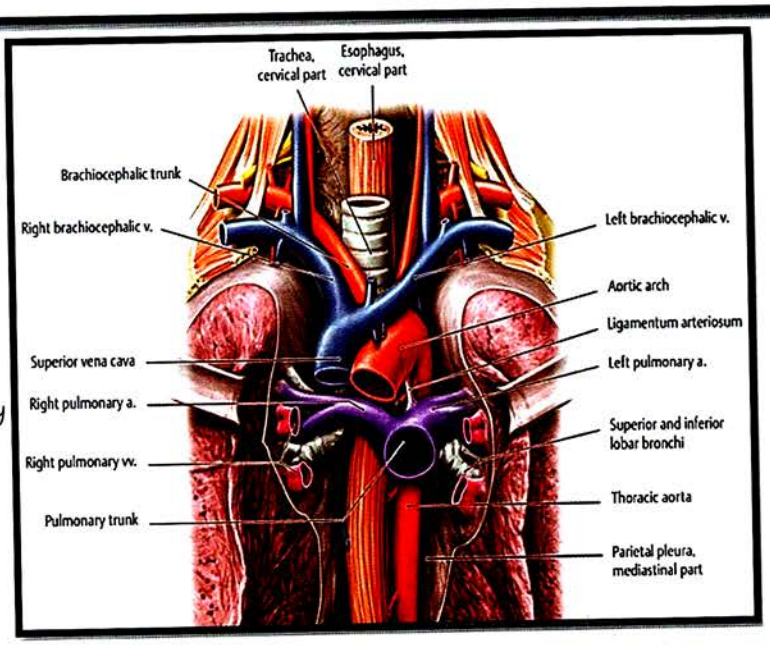


Lung has dual circulation

1. Bronchial artery → supply oxygenated blood to lung
2. Pulm. Artery bronchus → carry deoxygenated blood to lung

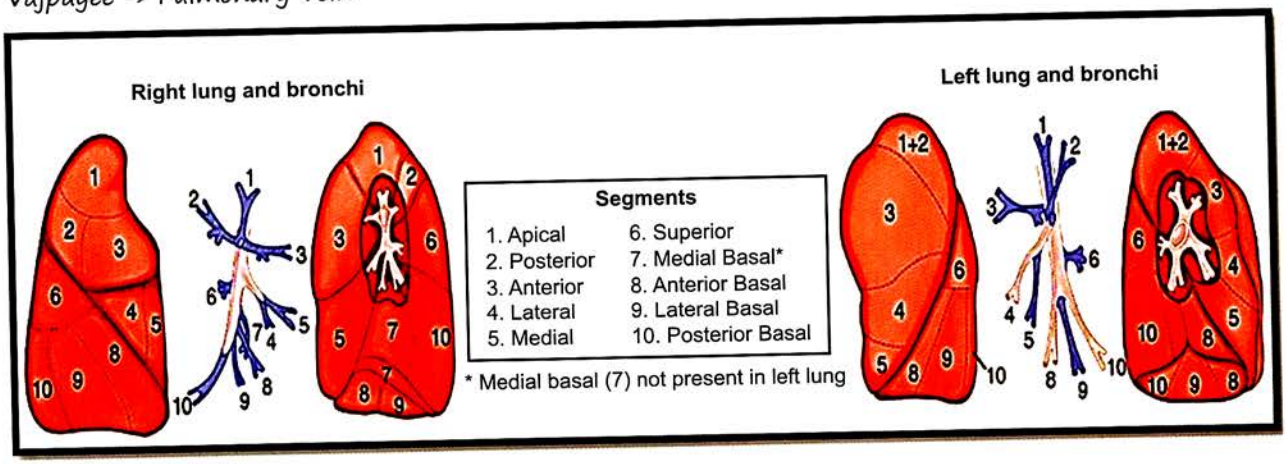
Hilum

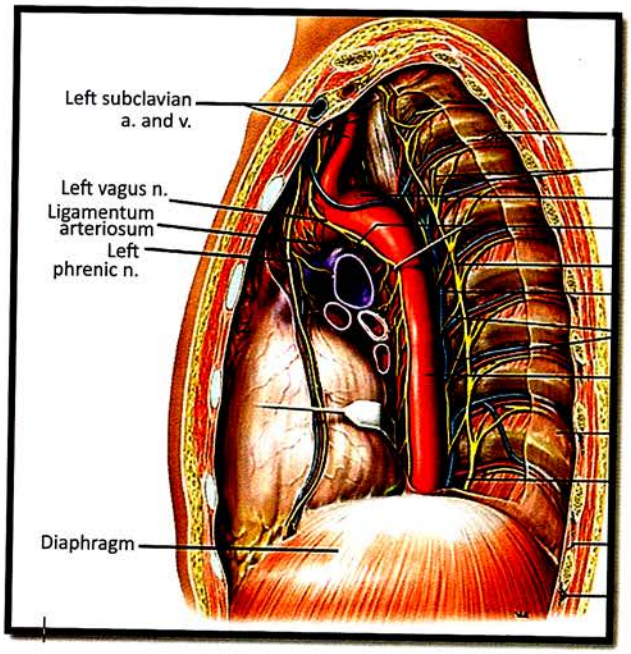
→ Bronchus is most posterior
→ Pulmonary veins are most anterior (2 superior & 2 inferior)
→ Pulmonary artery is b/w pulmonary veins & bronchus (most superior)

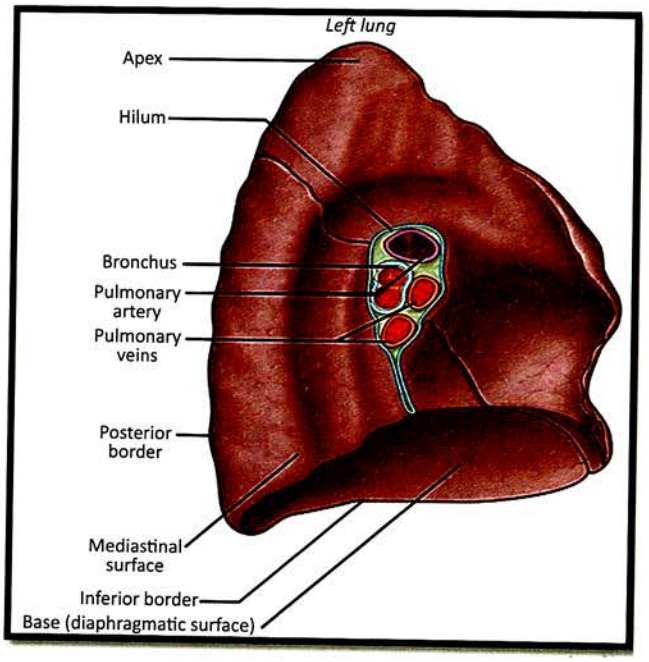


Superior to inferior :MNEMONIC-

Atal → Pulmonary Artery
Bihari → Bronchus
Vajpayee → Pulmonary Vein







Pleura surface markings

6, 8,10,12 → Inferior diaphragmatic pleural border of lung

Lung & pleura on rt. Side begins at mid sternal 6th rib

Then lung stays 2 rib higher than pleura

- Mid clavicular → 6
- Mid axillary → 8
- Paravertebral → 10

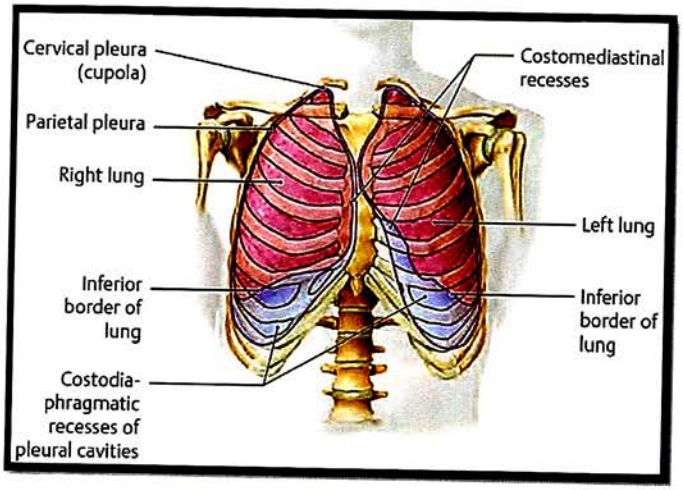
Rt. & Lt. lung surface markings are same

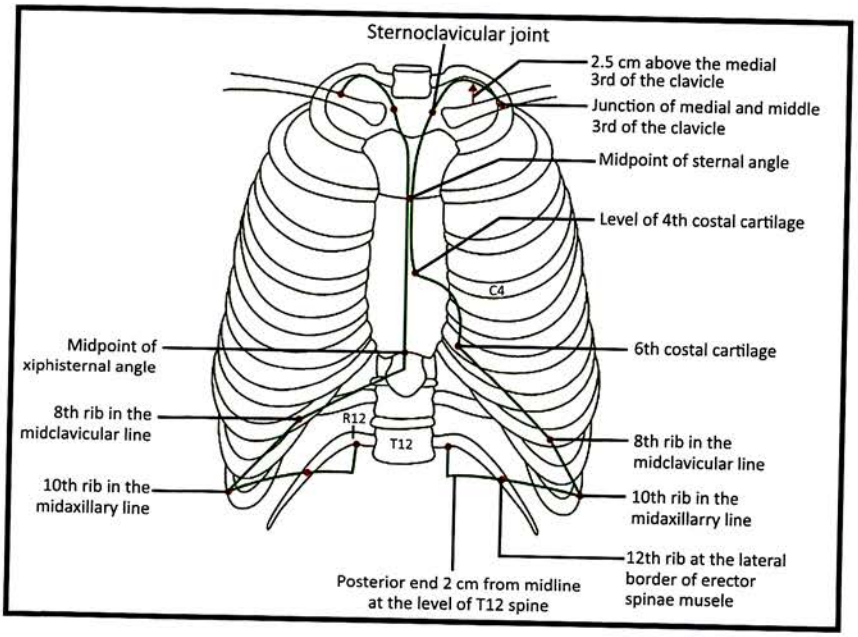
Except for mid sternal marking

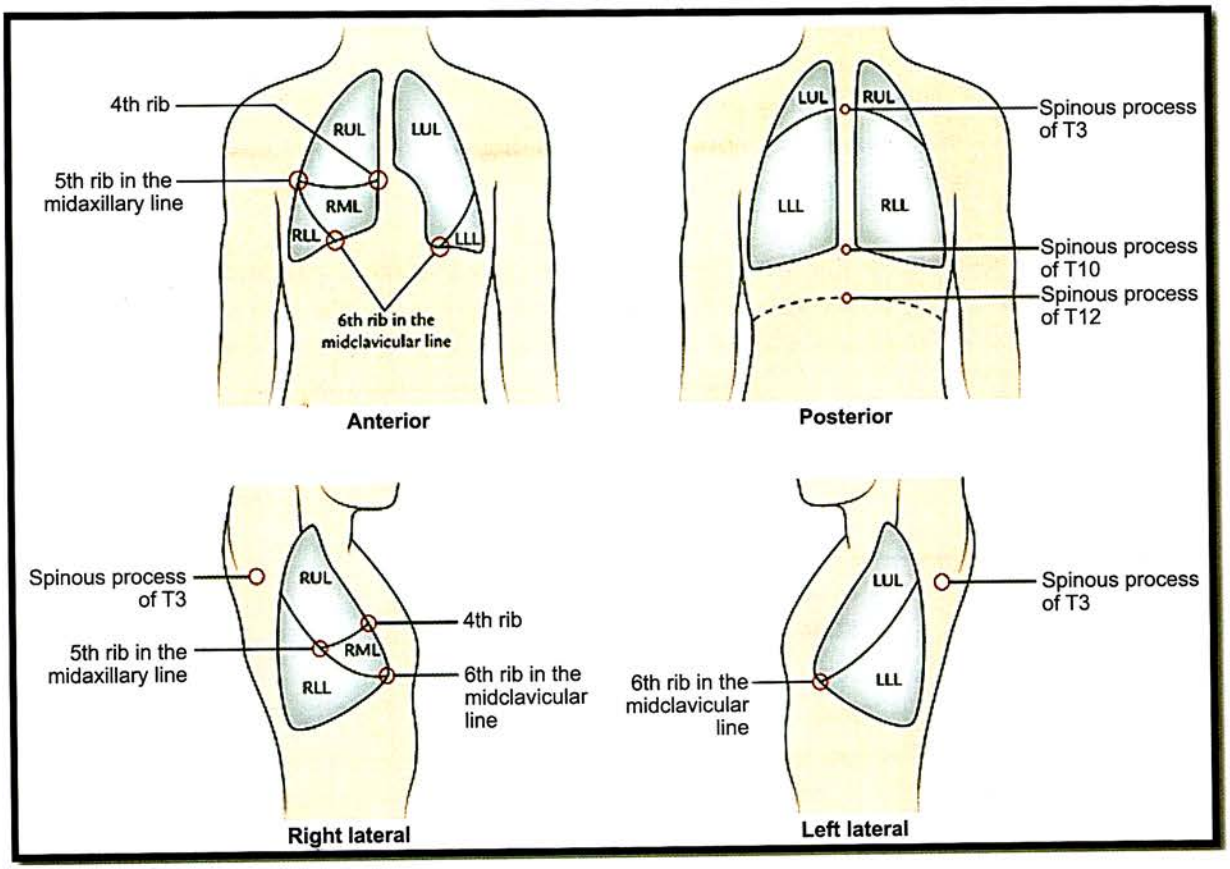
→ Rt. lung leaves sternum at 6th rib

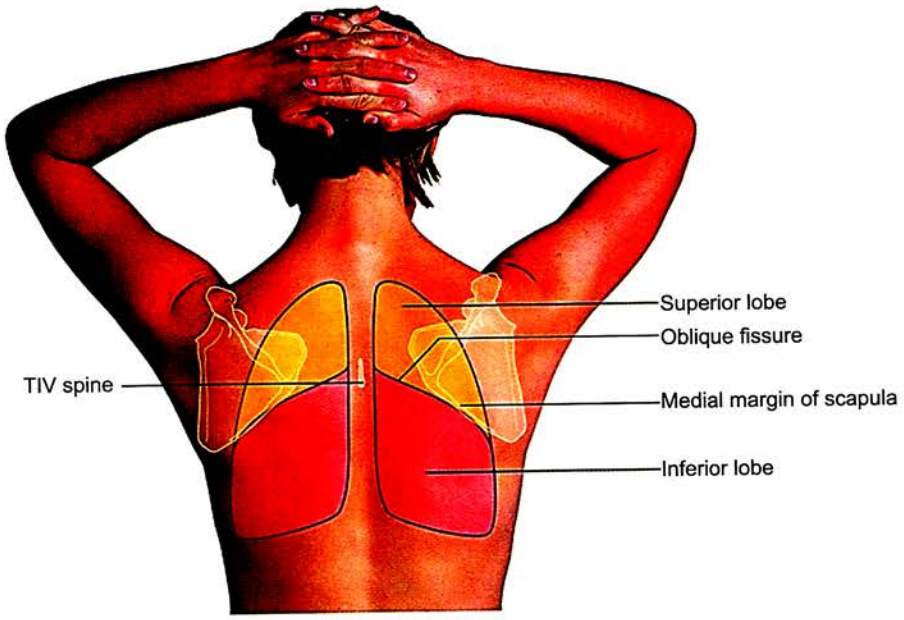
Lt. lung leaves sternum at 4th rib (to accommodate cardiac notch)

- → **Mid sternal → 6**
- → **Mid-clavicular → 8**
- → **Mid axillary → 10**
- → **Paravertebral → 12**









Sternal angle & mediastinum

Mediastinum

→ Middle septum, separating Rt. & Lt. lung

Inferior mediastinum

3 divisions

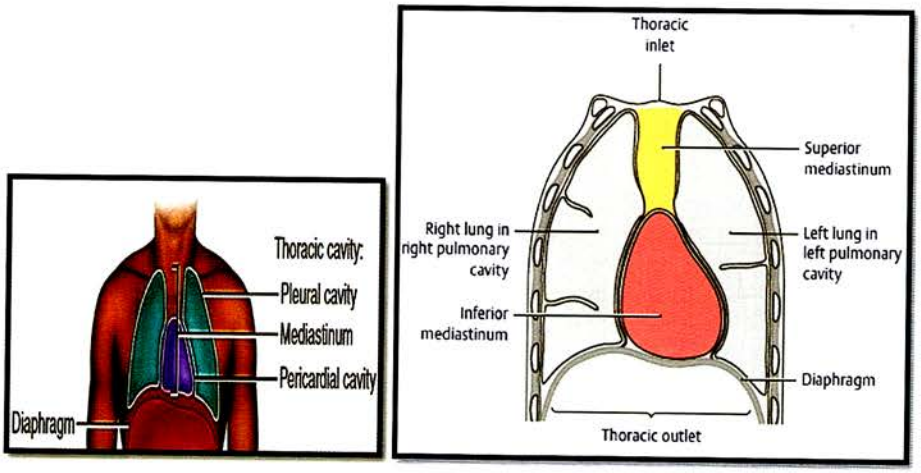
→ Middle mediastinum → Heart & ascending aorta present

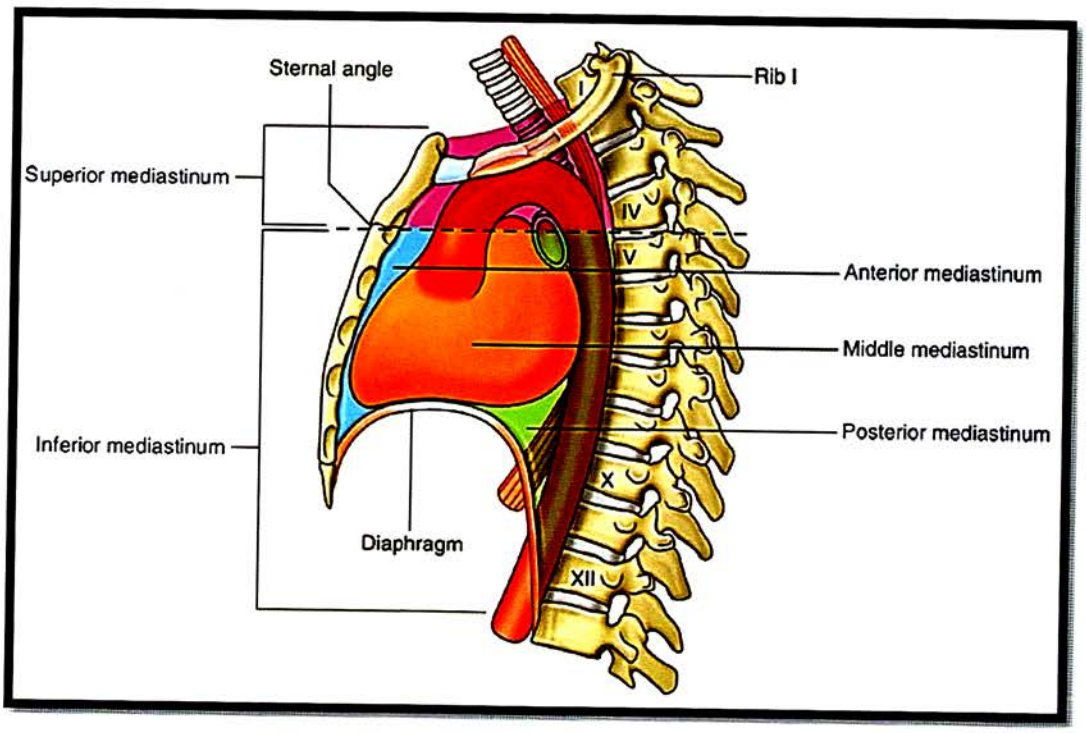
→ Anterior mediastinum → Space in front of heart

→ Posterior mediastinum → Space behind the heart
→ Longer than ant. mediastinum (upto T-12 level)
→ Descending thoracic aorta present in posterior mediastinum
→ Oesophagus → Superior mediastinum b/w trachea anterior & vertebra posterior
→ Posterior mediastinum

Sternal Plane

→ Disc b/w T-4 & T-5 vertebra & touching the sternum at manubriosternal junction
→ 2 costal cartilage, 2nd rib attach here
→ Separates superior mediastinum & inferior mediastinum

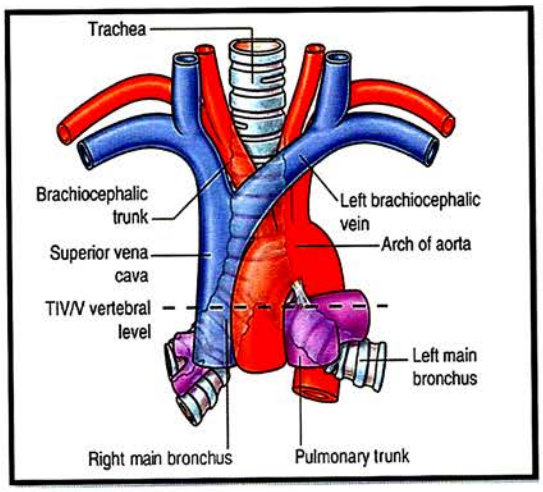




Sternal angle of Louis (163 degree) → Angle b/w manubrium & body of sternum

Arch of aorta

→ Present in superior mediastinum behind the manubrium bone
→ Begins & ends at the level of T-4 (sternal plane)
→ Begins at 2nd costal cartilage
→ Comes from Rt. to Lt. side

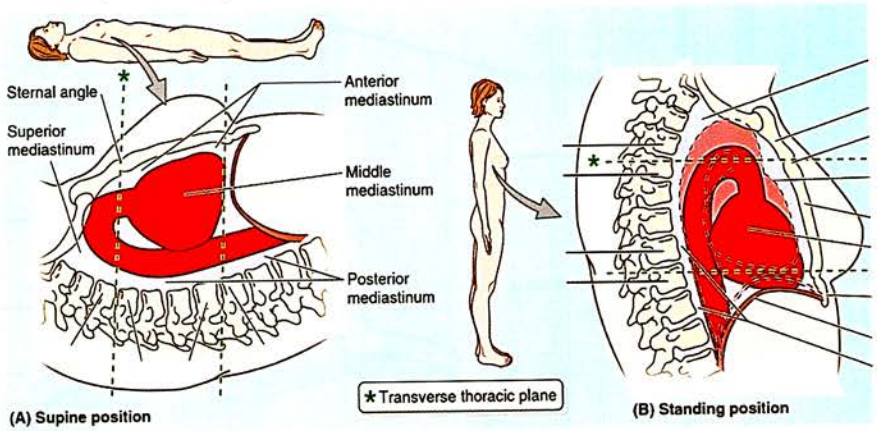


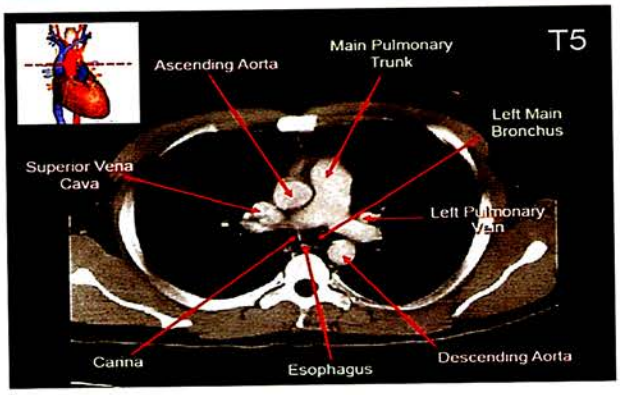
T-5 vertebra level & structure

→ Carina → cartilage at the bifurcation of trachea
→ Lt. principal bronchus
→ Rt. principal bronchus
→ Ascending aorta (anterior)
→ Descending aorta (posterior)
→ Pulmonary trunk dividing into Rt & Lt pulmonary arteries.

Extent of heart rise

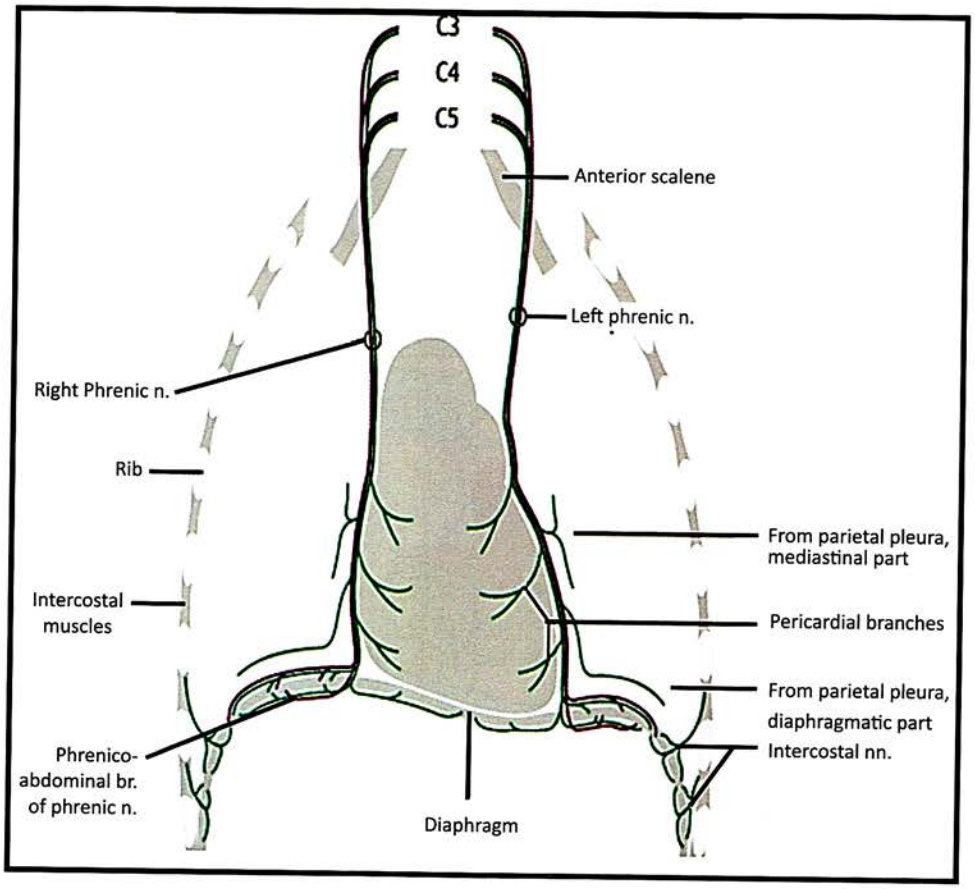
In Supine heart rises to T5-T8
In Standing heart rise to T6-T9





Phrenic nerve

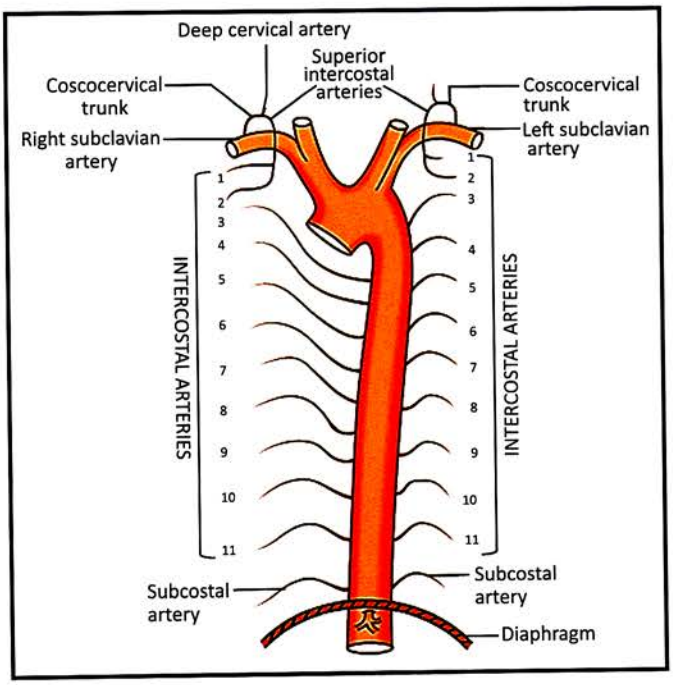
→ Comes from cervical plexus, root value → C-3, 4,5
→ Diaphragm develops from cervical somites, root value → C-3, 4,5
→ Comes from anterior primary ramus of spinal nerves 3,4,5
→ Runs anterior to scalenus anterior & hilum continues in thorax region on the side & reaches diaphragm
→ Only motor nerve to diaphragm
→ Sensory to central portion of diaphragm
Peritoneum under central diaphragm
Pericardium on mediastinum
Pleura towards the mediastinum
→ Inter costal nerve carries sensations from
→ Periphery of diaphragm
- Periphery of peritoneum
- Costal & peripheral diaphragmatic pleura
- Rt. phrenic nerve is short & straight (dome of diaphragm pushed up by liver) Left phrenic nerve is long & oblique (dome of diaphragm pushed down by heart.



Hilum of lung present b/w hilum of lung anteriorly & vagus nerve posteriorly
→ SVC enters the RA at T-5 level
→ IVC pierces the central tendon of diaphragm at T-8 level & enters RA

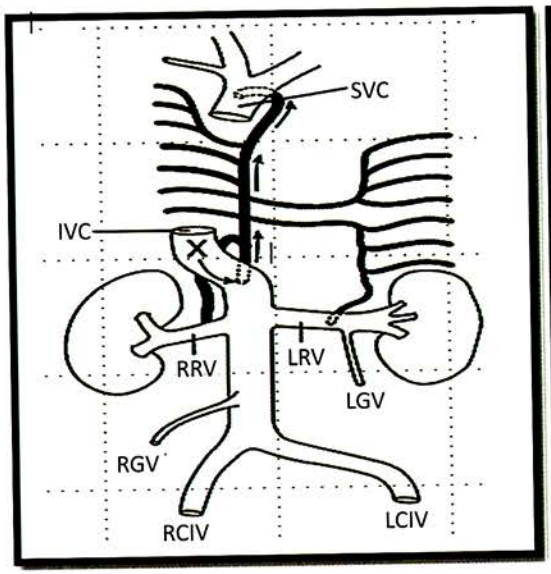
ARTERIAL SUPPLY OF THORAX:

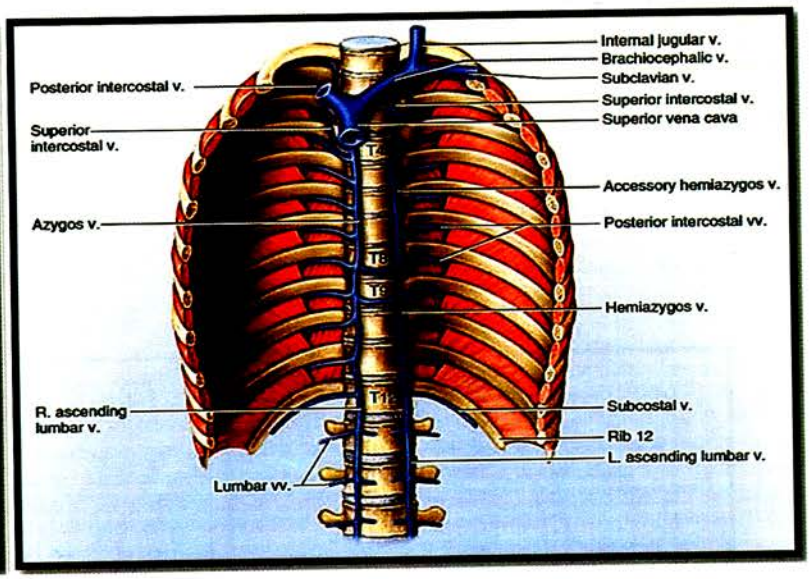
Descending thoracic Aorta gives Post intercostal Arteries (PICA), one in each I/C Space. 1&2 PICA arise from branches of subclavian A, while 3-12 are coming from Descending thoracic aorta.



Venous drainage of heart:-

- → Azygous vein
- → Puncture right crus of diaphragm & enters the thorax & enters SVC at T-4 level
- → Left thorax





Hemi Azygous vein

- → formed in abdomen & puncture the left crus of diaphragm to enter the thorax & drains the lower intercostal spaces

Accessory hemiazygous vein → drains upper intercostal spaces

Both hemiazygous vein & accessory hemiazygous vein turns towards right to thorax & pass behind the heart & drain into azygous vein both veins cross at T-8 level

Block in inferior vena cava

→ Collaterals from IVC joins azygous veins & drains into SVC

Block in SVC → collaterals from SVC joins azygous veins & drains into IVC & finally into RA

In both cases azygous vein is dilated

Lymphatic drainage:

→ **Rt. half of body above diaphragm**

→ **Rt. side of head & neck**
Rt. side of thorax
Rt. upper limb → **Rt. lymphatic duct**

→ **All other body** → **Thoracic duct**

Rt. Broncho mediastinal trunk (thorax)
Rt. Sub clavian trunk (UL)
Rt. Jugular trunk (head & neck)

↓

Rt. Lymphatic sub clavian

↓

Rt. Jugulo subclavian venous angle

↓

Lt. Bronchomediastinal trunk (Thorax)
Lt. Subclavian trunk (UL)
Lt. Jugular trunk (head & neck)

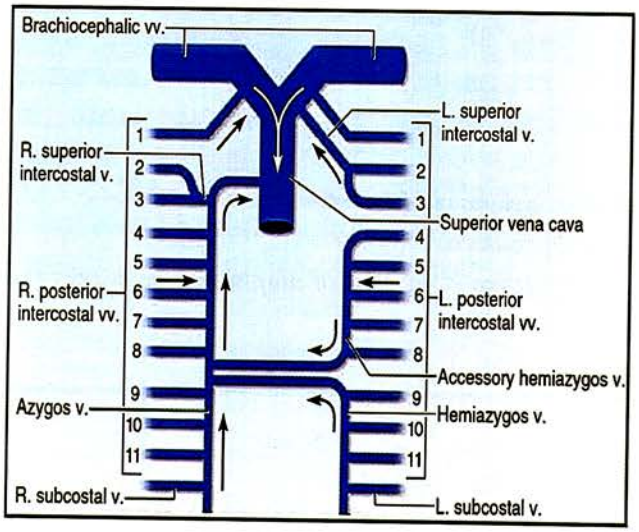
↓

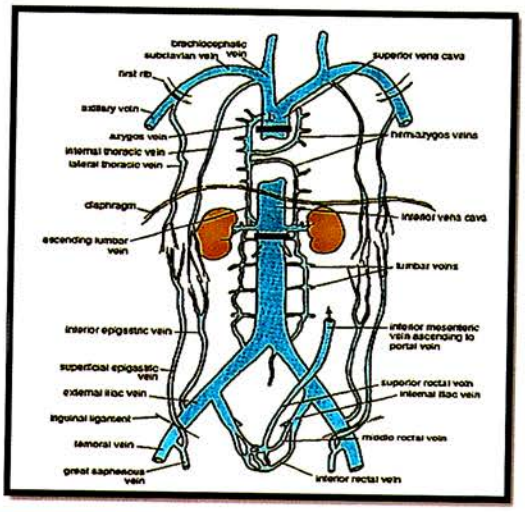
Thoracic duct ← Cisterna Chyli

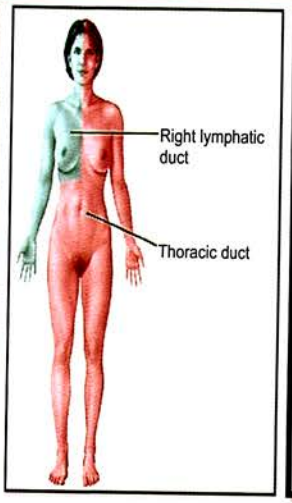
↓

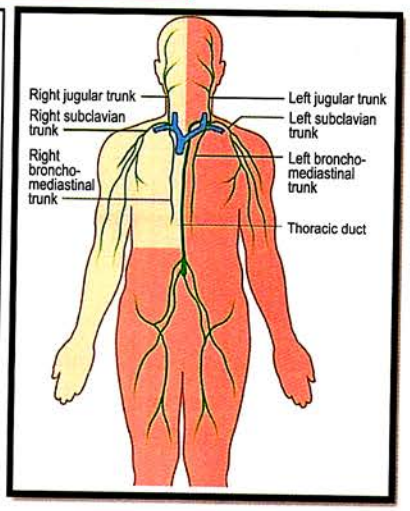
Left Jugulo subclavian venous angle

Body below the diaphragm (abdomen, UL, Perineum) ↑







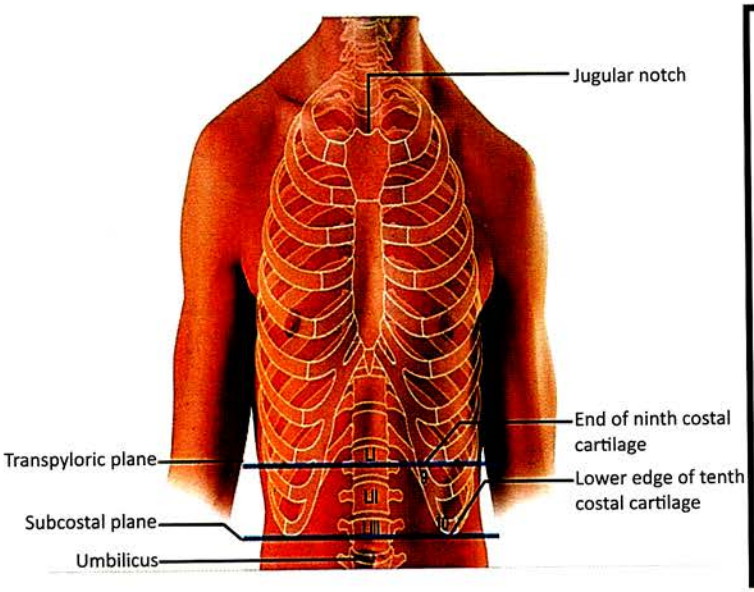


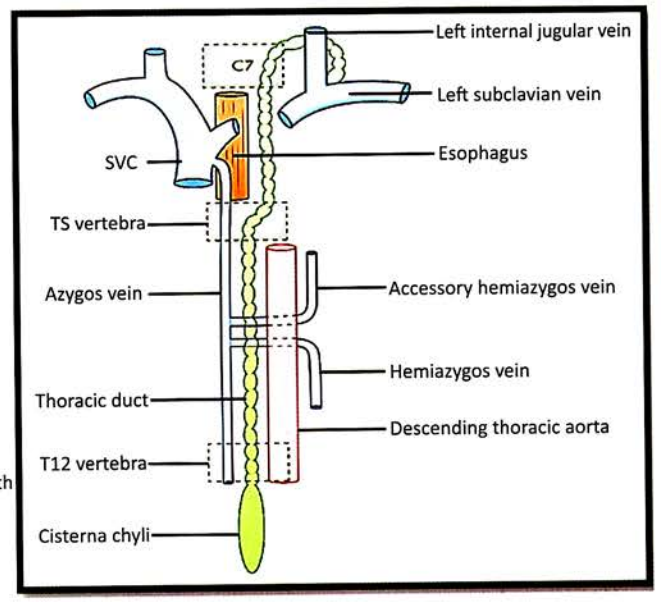
THORACIC DUCT COURSE:

Cisterna chyli → present at the level of L-1, & L-2

Aortic hiatus

→ Passage present in diaphragm at lower border of T-12 from which descending thoracic aorta passes & continues as Abdominal aorta





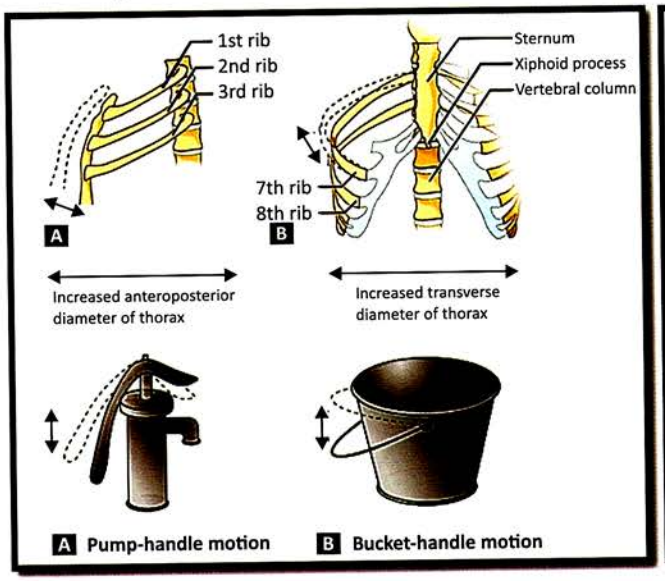
Thoracic duct

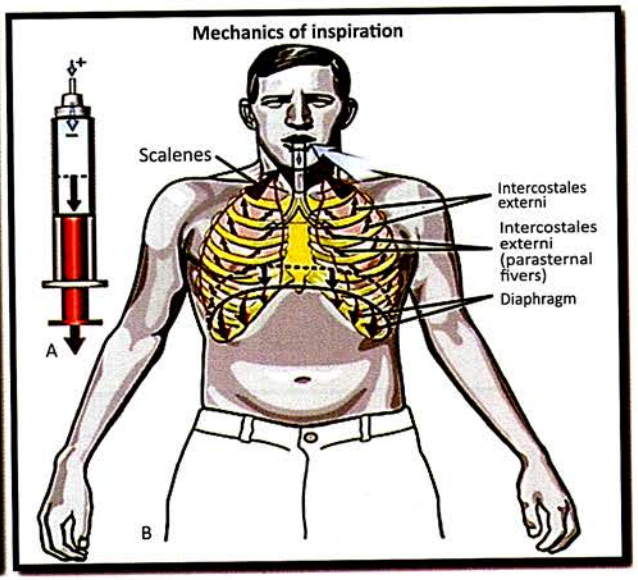
→ Continuation of cisteria chyli passes through aortic hiatus

→ Begins at lower border of T12, Rt. to aorta

→ At T-5, crosses to left side & and drains Lt. jugulo sub-clavian venous angle at C-7

Breathing movements:-





Upper ribs->Pump handle movements (sternum moves ant & post, AP dia of thorax increases)

Lower ribs-> Bucket handle movements (transverse dia of thorax increases).

Chief muscle of inspiration is Diaphragm.

Muscles Of Expiration

Ant abdominal muscles.

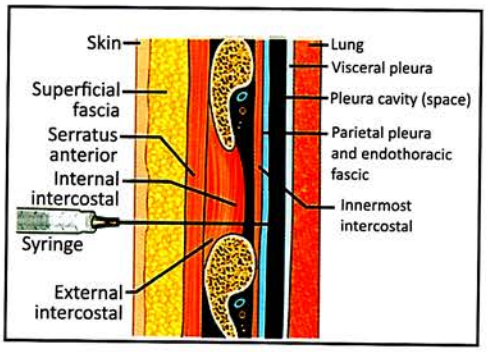
Forceful expiration by lateral fibres of muscle

Ant interchondral muscle part is for DEEP inspiration

Aspiration of pleural effusion:-

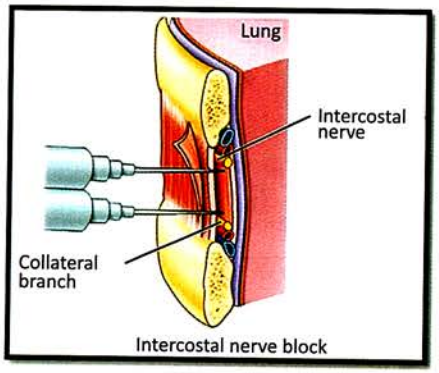
VAN structures are pierced from up to down while aspirating i.e. Vein, artery and nerve.

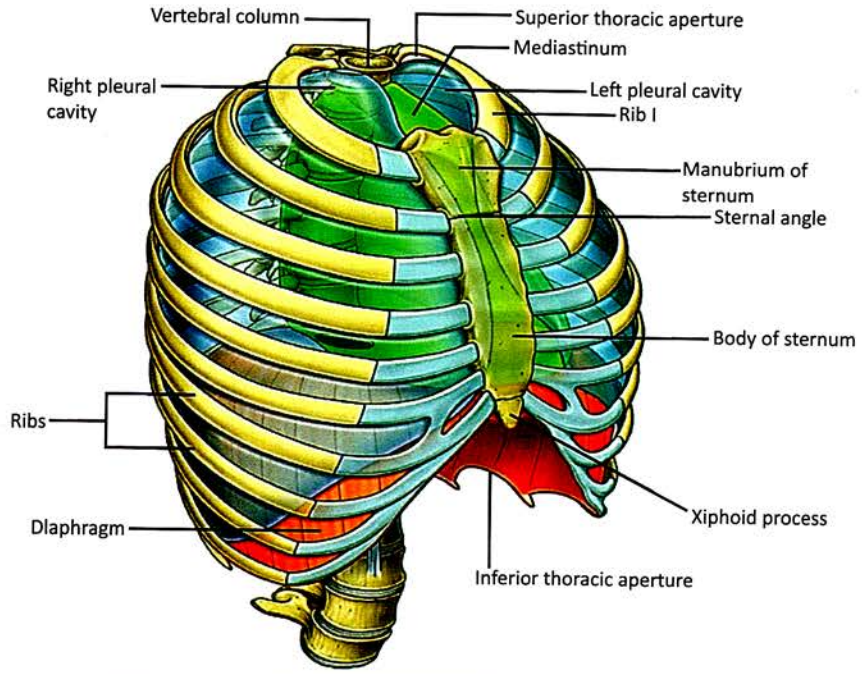
It is given below the rib border always.

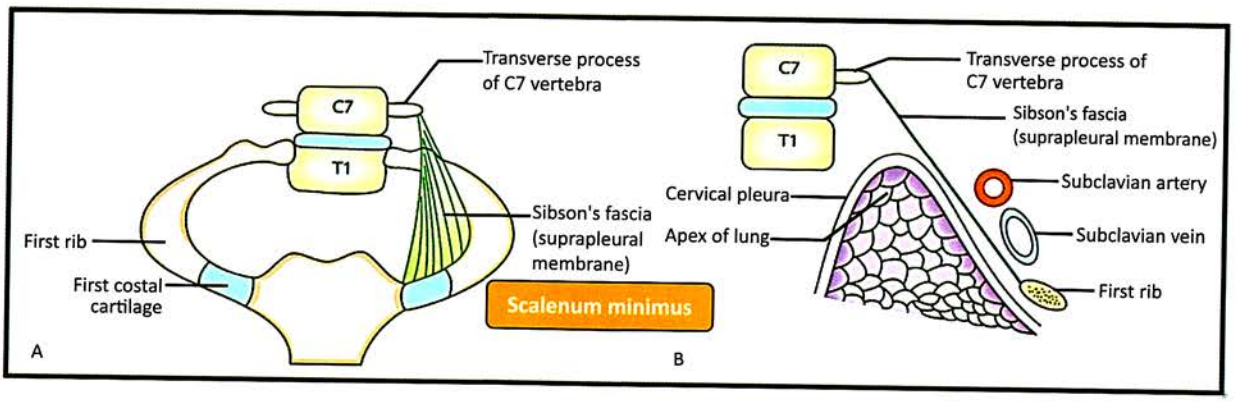


Intercostal block :

Give below and above the rib due to presence of collaterals, otherwise pain persists.





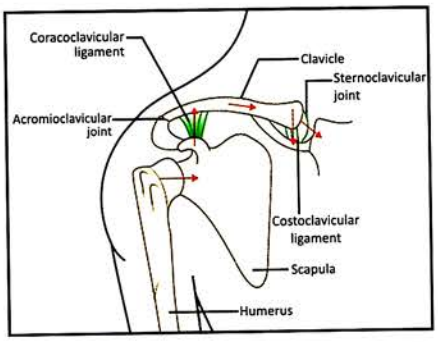


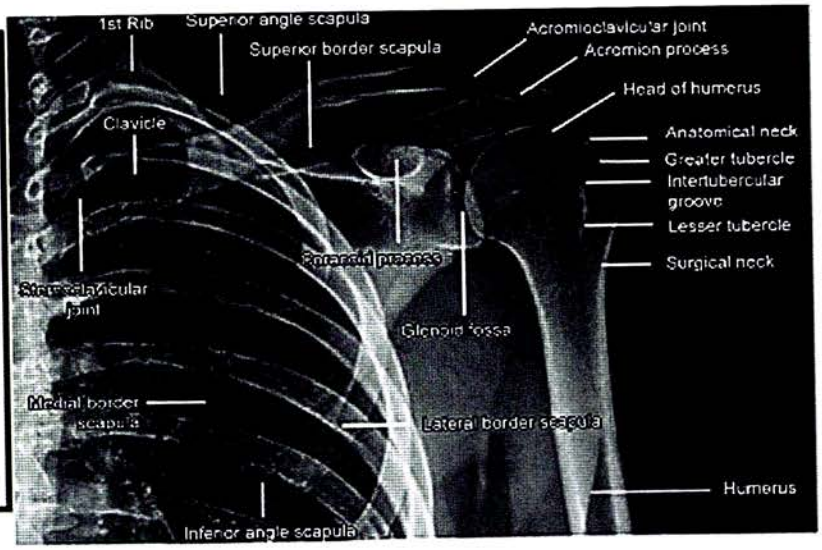
Upper Limb

Transmission of weight in upper limb:

Upper limb to → Clavicle via Coraco-clavicular ligament

Upper limb to → Axial Skeleton via Costo Clavicular ligament





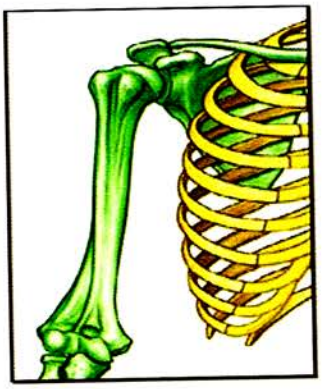
Clavicle:

→ Only long bone lying horizontally

→ Only long bone with 2 primary Centers of ossification.

→ Lies Subcutaneous

→ Fractures more common in middle 1/3rd Part. (Junction of medial 2/3rd & lateral 1/3rd).

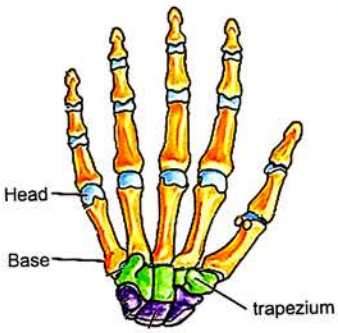


a) **Coracoid Process of Scapula:** Atavistic epiphysis

b) **Traction epiphysis:** Lesser & greater tubercle
Lateral & Medial epicondyle humerus

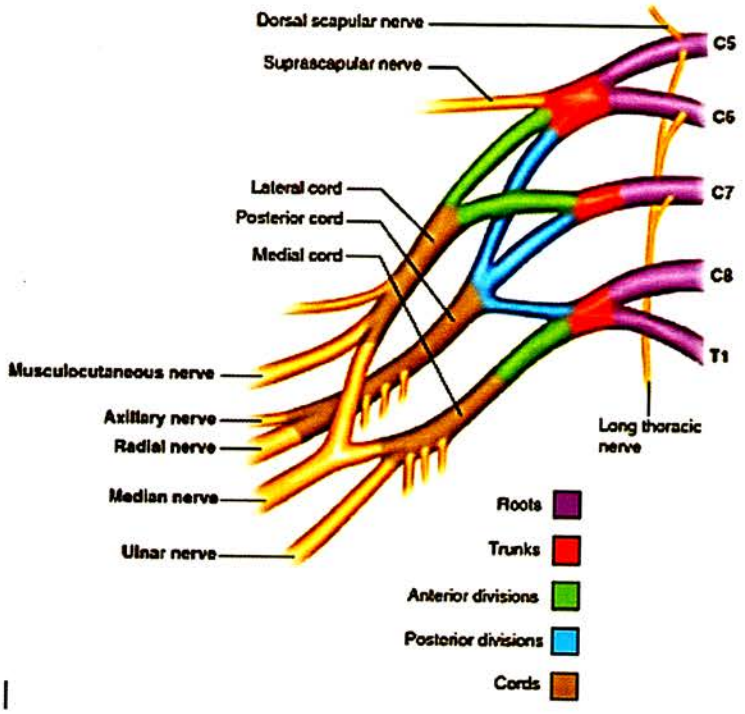
c) **Pressure epiphysis:** → Head of humerus
→ Condyle of humerus

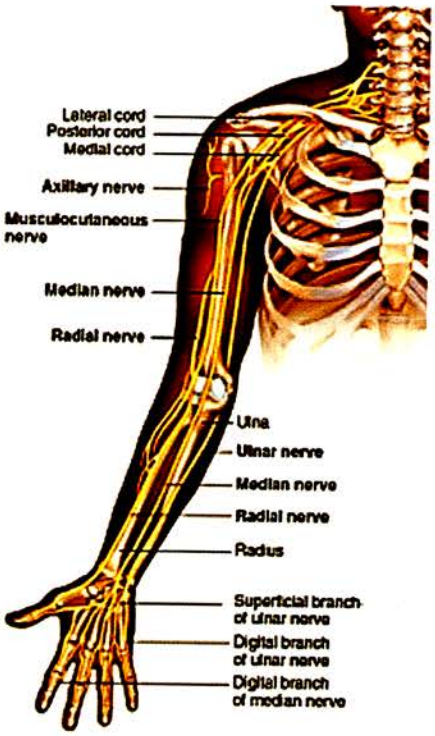
Epiphysis lies @ head of all metacarpals in hand
[Except: 1st Metacarpal → epiphysis lies at base]
Aberrant epiphysis: when epiphysis lies at head of 1st metacarpal



Brachial Plexus:

$C_{5,6,7,8}, T_1$ → Supply upper limb





Br. Plexus

→ Partly lies in Neck & Partly in Axilla

↓ Roots & Trunk

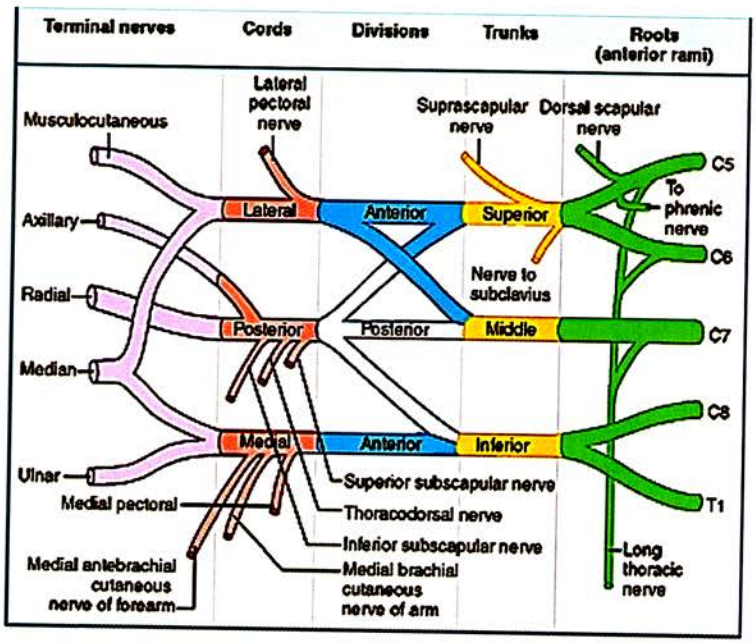
↓ Cords & Branches

ROOTS: C_5, C_6, C_7, C_8, T_1

TRUNKS: (3) Upper, middle ,Lower trunk

DIVISIONS: Total 6

→ Each Trunk gives Ant. and Post division Pass behind the bone (clavicle)



CORDS: Enter Axilla

→ 3 in number i.e. Lateral, Posterior, Medial Cord

→ Named accordingly to Relation with Axillary Artery

1. **Lateral Cord** → It is formed by Ant. Division of upper & middle trunk and Continues as **Musculocutaneous Nerve**
2. **Posterior Cord** → Continues as **Radial Nerve.** Posterior divisions of all 3 trunks form posterior cord.
3. **Medial Cord** → continues as **Ulnar Nerve.** Medial cord is a continuation of Ant. Division of lower trunk

Root Values: Normally, the upper Root values $C_{5,6,}$ go to upper trunk & some of branches are given proximally. Lower root values C_8, T_1 will be given in Lower Trunk & Some of the nerves run distally

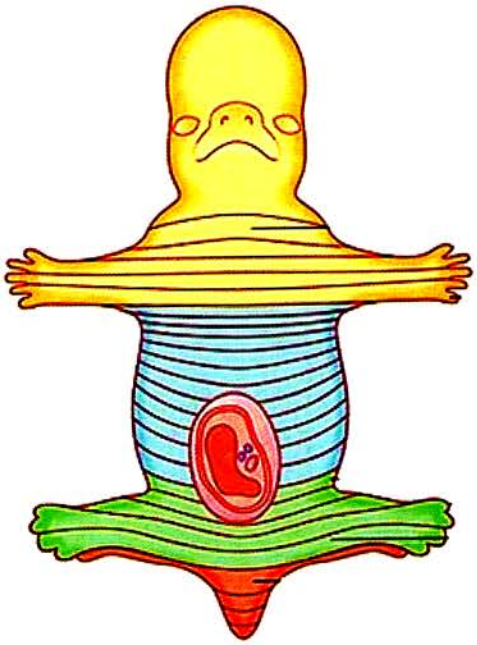
(For e.g. Ulnar Nerve Root value → C_8, T_1
Axillary Nerve Root value → C_5, C_6)

→ But some Nerves can have all the root values

Radial Nerve
Medial Nerve
} → C_5,6,7,8, T_1.

Proximal Root Values → Supply Proximal muscles i.e Shoulder/ Arm/ Scapular muscles

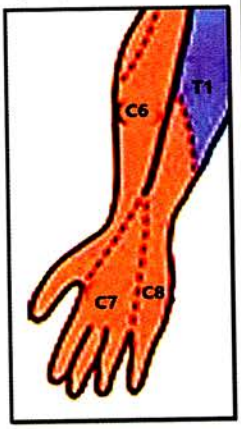
Distal Root Values → Supply Distal Muscles
↓
Hand Muscles

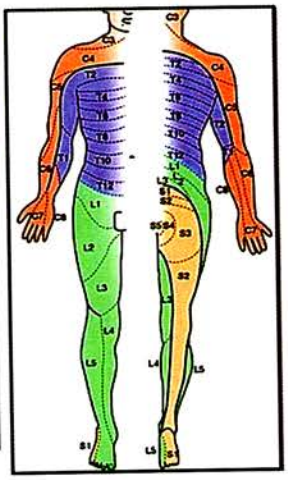


Upper Trunk Branches:-

→ Suprascapular Nerve
→ Nerve to Subclavius
} → No Branches
Lower Trunk

Long Thoracic Nerve → Comes directly from Roots of C_5, C_6, C_7,

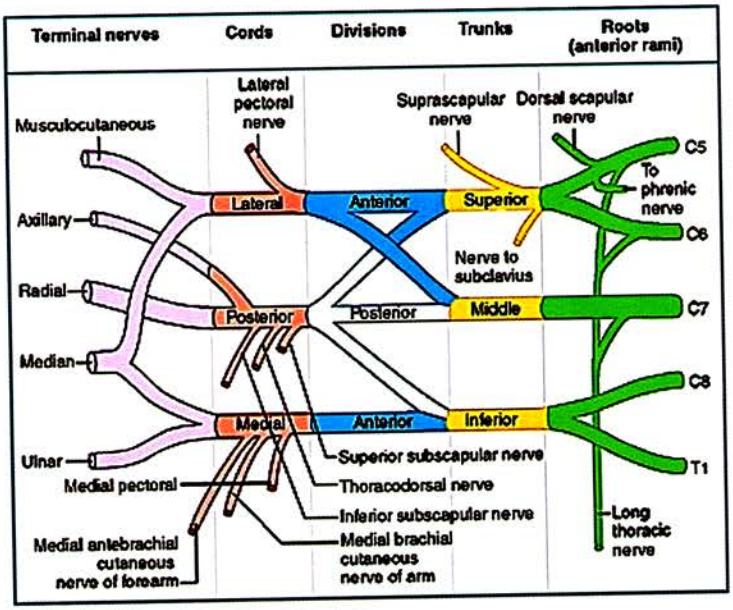




DERMATOMES

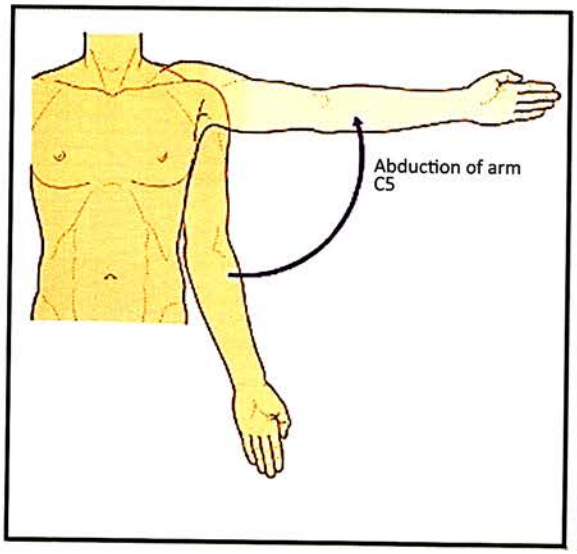
Upper body will have upper Root values & lower body will have lower Root Values.

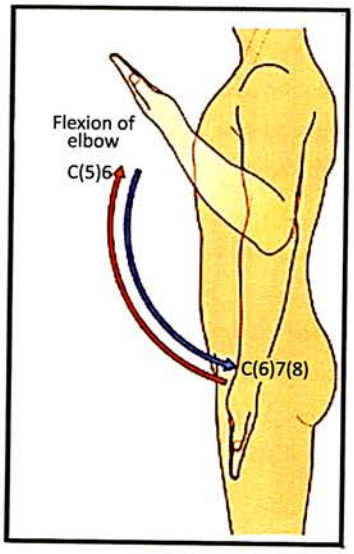
E.g. Thumb → C_6
Middle 3 Fingers → C_7
Little finger → C_8

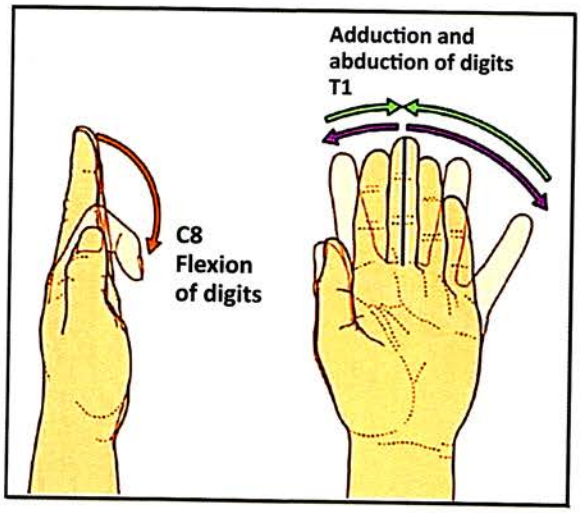


The muscles of Shoulder, Scapular, arm are C_5, C_6 & they are involved in shoulder Abduction & elbow flexion.

In case of injury to C5, C6 → difficulty in shoulder Abduction & elbow flexion







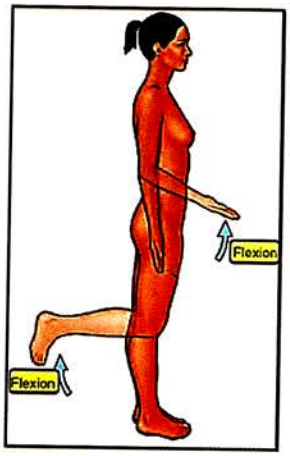
C_8, T_1 → is the Root Value of muscles of hand.

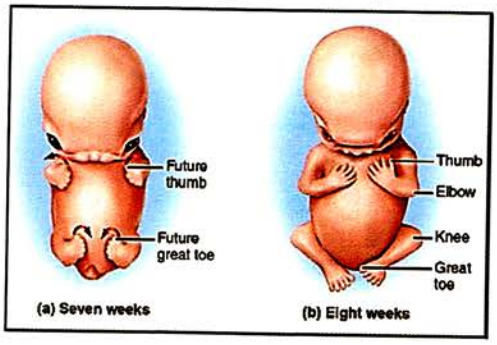
Muscles of hand will be compromised in Klumpke's Palsy. There will be difficulty in folding the finger & spreading/ Closing the fingers (functions of interossei muscles). It is K/A **CLAW HAND DEFORMITY**

↓

In Erb's Palsy → Problem in upper trunk region i.e. root values C_5, C_6

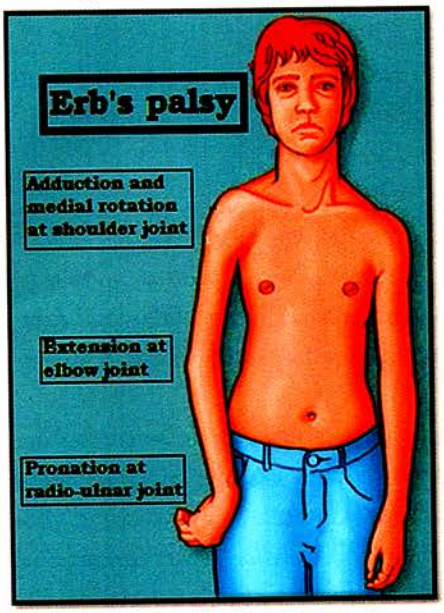
In Klumpke's Palsy → there is problem in lower trunk region ie C_8, T_1





During Development, the upper limb rotates laterally 90°, so that the thumb comes lateral. Lower limb rotates medially by 90°, So that the great toe comes medial.
The upper limb folds anteriorly, so the flexor compartment is anterior whereas the lower limb folds posteriorly, so the flexor compartment is posterior.

Nerves involved	Cause of injury	Clinical features
Erb-Duchenne palsy (upper turnk; C-5L, 6 injury) ▪ Supra-scapular nerve ▪ Axillary nerve ▪ Musculocutaneous nerve ▪ Radial	Undue separation of head and neck ▪ Fall on shoulder ▪ Birth injury	Policeman tip hand deformity



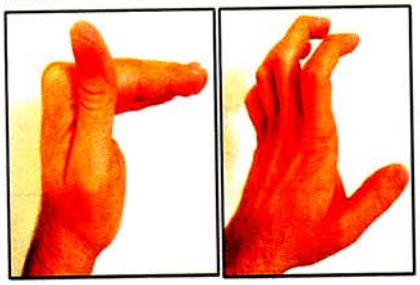
Erb's Palsy: It is also k/a Policeman tip hand deformity
There are some nerve involved (C_5, C_6)

Cause:

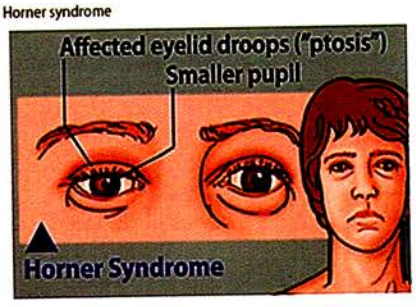
→ Could be birth injury or sports injury

Undue separation of head & shoulder leading to difficulty in shoulder abduction & lateral rotation. So the limb lies in adducted & medially rotated position. Elbow cannot flex so it remains in extension. Hand cannot do supination so it will remain in prone posture.

Nerves involved	Cause of injury	Clinical features
(**Lower trunk**; C-8; T-1 injury) ▪ Median nerve ▪ Ulnar nerve ▪ T-1 Sympathetic fibres	**Hyper-abduction** of arm ▪ Holding a branch while fall from a tree ▪ Birth injury	**Claw hand deformity**



Horner syndrome



Klumpke's Palsy: There in injury of root values C_8, T_1

Etiology

→ Birth injury

→ Sports injury

→ Hyper abduction injury

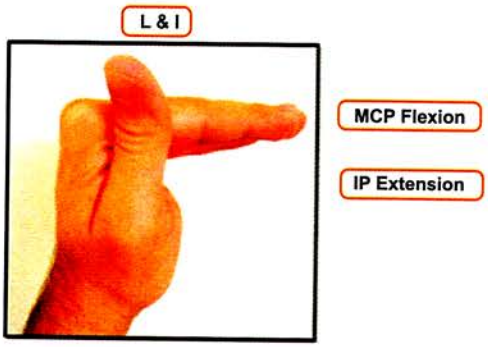
It leads to **Claw hand deformity** features of Horner's syndrome can also be seen i.e. Ptosis, Miosis.

Claw Hand: Normally there are 4 lumbricals muscles, 4 palmar interossei and 4 dorsal interossei

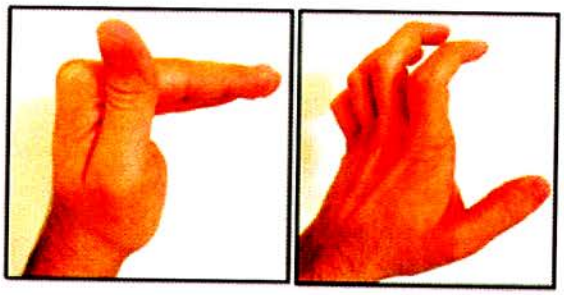
They all do 2 activities

1. Flexion at MCP Joint.
2. Extension at IP Joint.

Extensor digitorum muscle tendon gives dorsal digital expansion which causes interphalangeal extension and into that are inserted interossei muscles & lumbricals



In Claw hand, if the lumbricals interossei are not working then forearm muscles become more powerful. Posterior forearm muscle i.e. extensor digitorum lead to MCP Joint Hyper extension, Ant. forearm muscle i.e. FDP leads to flexion at interphalangeal joint. Normally forearm muscles are balanced by lumbricals interossei. If they are not working forearm muscle become more powerful leading to CLAW HAND DEFORMITY.

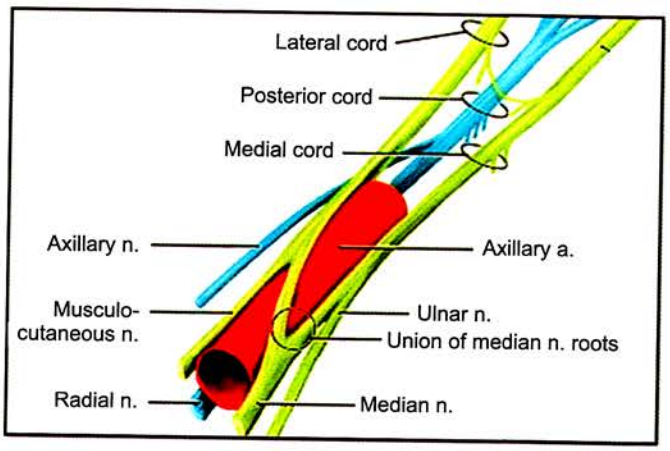


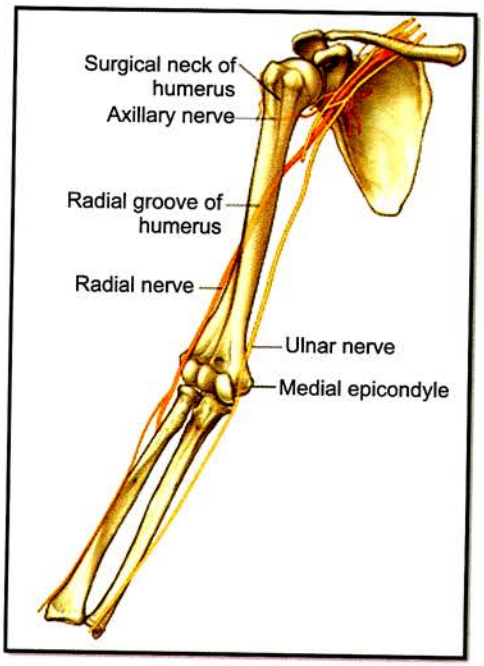
Post Cord course

→ Continues as Radial nerve which passes through lower triangular space in scapular region & goes behind humerus, into the radial groove, comes in front of lateral epicondyle & runs along with radial bone.

→ Median nerve is running in relation to Cubital fossa in midline ulnar Nerve (continuation of median cord), passes behind medial epicondyle, runs along Ulna bone.

Axillary Nerve passes in quadrangular space of scapular region & is related to surgical neck of humerus bone.





Branches of Post. Cord

5 Branches:

S T A R S

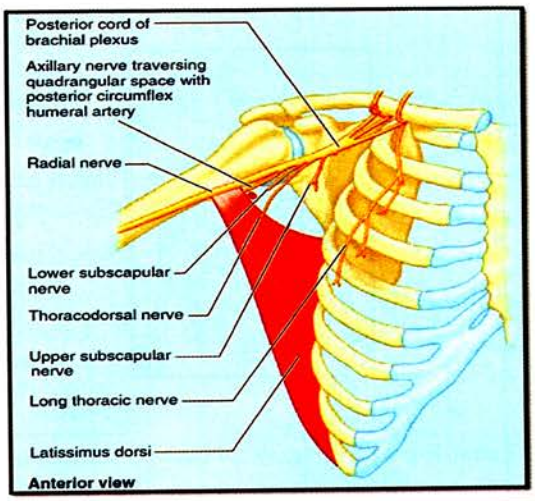
S → Upper subscapular nerve

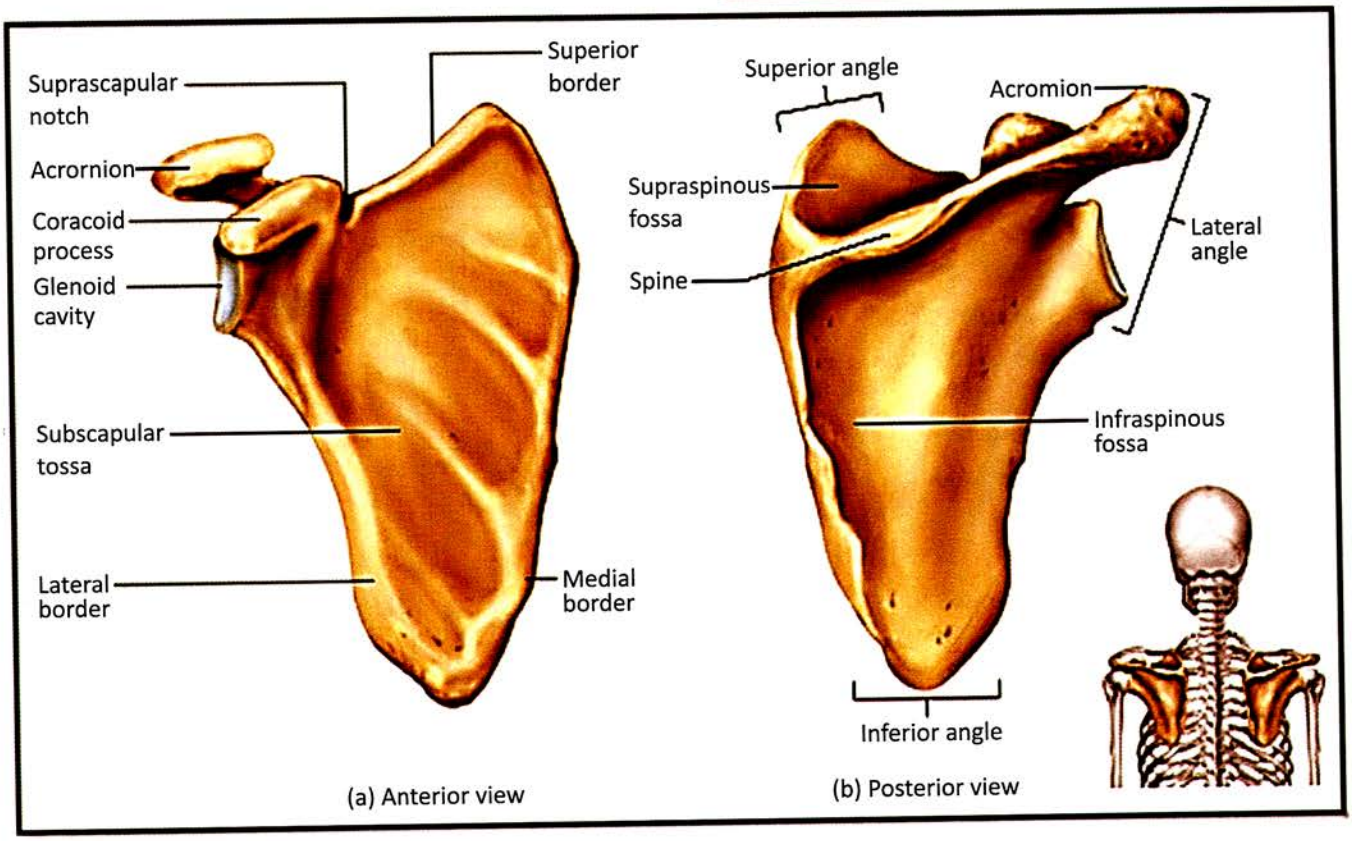
T → Thoracodorsal nerve (supplies L. dorsi)

A → Axillary Nerve

R → Radial Nerve

S → Lower subscapular nerve





Scapula & muscular attachment

Anteriorly, supraglenoid tubercle gives rise to long head of Biceps Brachii.

Subscapular fossa gives rise to subscapularis muscle.

Insertion of S. anterior muscle on medial border of scapular on ant. aspect Dorsally,

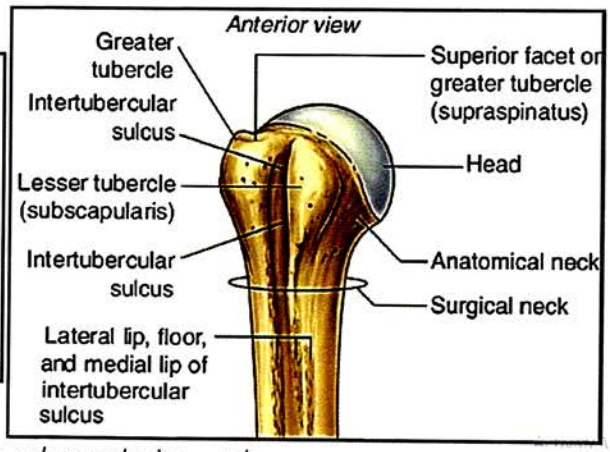
→ Spine of scapula is present above which there is insertion of supraspinatus muscle,

→ Teres minor originates from lateral border of scapula.

→ Trapezius muscle inserted on upper border of spine of scapula & medial border of acromion process.

→ Lower border of spine of scapula gives origin to deltoid muscle, continuous on lateral border of acromion process also.

Infraglenoid tubercle gives origin to long head of Triceps muscle.



→ Lesser Tubercle gives insertion to subscapularis muscle.

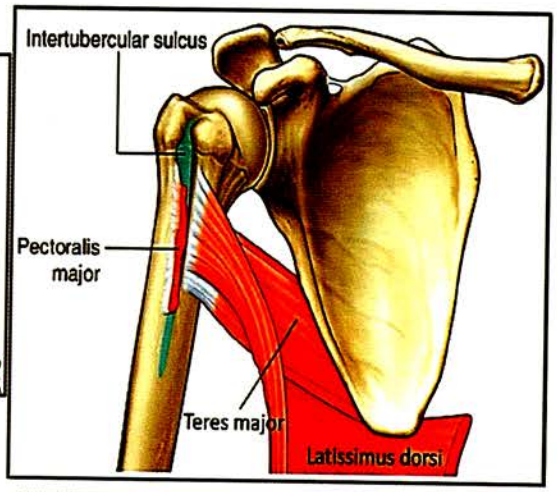
→ Glenoid muscle gives insertion to

S → Suprasinatus Muscle

I → Infraspinatus

T → Teres Minor

Bicipital groove: Long head of Biceps brachii passes through this. Latissimus dorsi muscle get inserted on floor of Bicipital groove.



Mnemonic:

"LADY BETWEEN 2 MAJORS"

Lateral lip of B. groove is insertion of

↓

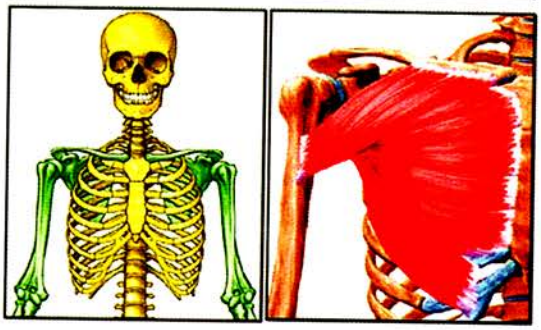
Pectoralis Major

Medial lip of B. groove is insertion of

↓

Teres major

Floor contains L. Dorsi muscle



Axilla:

3 muscle lie in post wall of Axilla:

→ L. Dorsi

→ Teres major

→ Subscapularis muscle

2 muscles lie in Ant wall of Axilla:

→ Pectoralis major

→ Pectoralis minor

Lateral border of Axilla: Humerus Base

Medial border of Axilla: Upper 3 weeks giving origin to S. anterior muscle

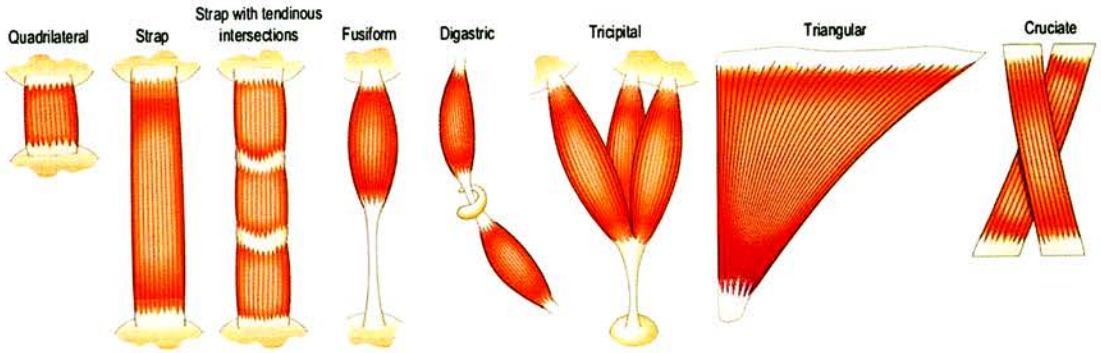
P. Major Muscle:

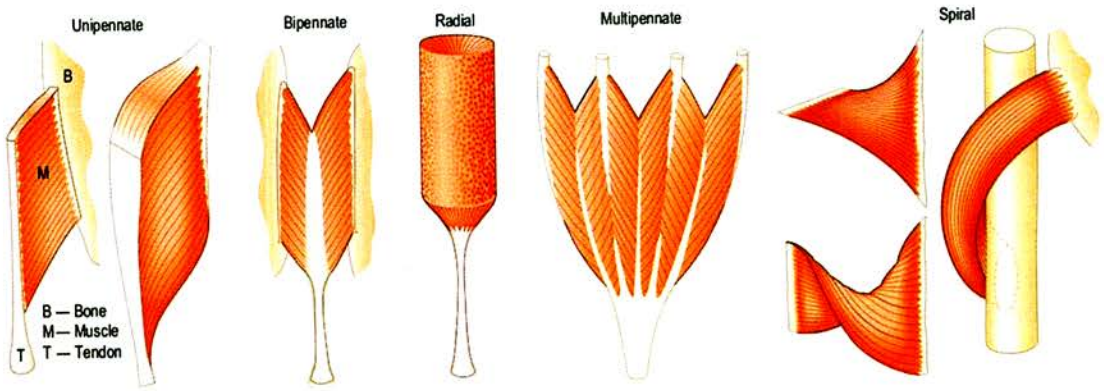
Origin: large muscle arising from clavicle, sternum & costal cartilage

Insertion: Lat. Lip of bicipital groove, fibres have 180 spiral

→ Upper fibres from clavicle get inserted at lower level

Lower fibres get inserted in upper border of lateral lip of bicipital groove.





Types of muscle based on shape

→ **Strap muscles:** e.g.: Sternothyroid
↓ Sternohyoid
Anterior neck

→ **Triangular muscle:** e.g. Temporalis

→ **Cruciate muscle:** e.g. SCM

Digastric
- → Anterior-belly
- → Post belly

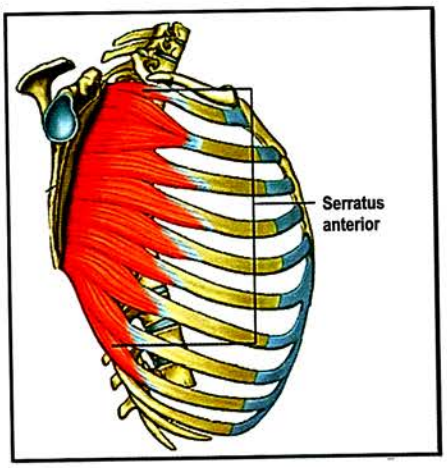
→ **Tricipital:** e.g Triceps
- → Long head
- → Lat. head
- → Med. head

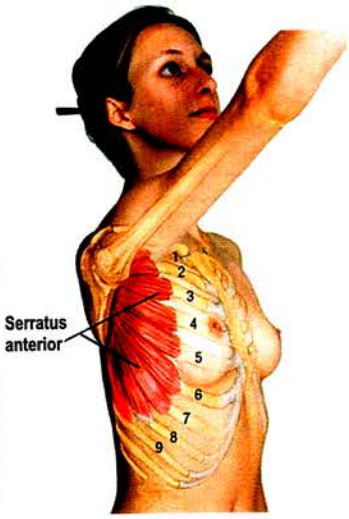
→ **Unipennate muscle:** FPL

→ **Bipennate muscle:** Dorsal interossei

→ **Multipennate muscle:** Deltoid muscle

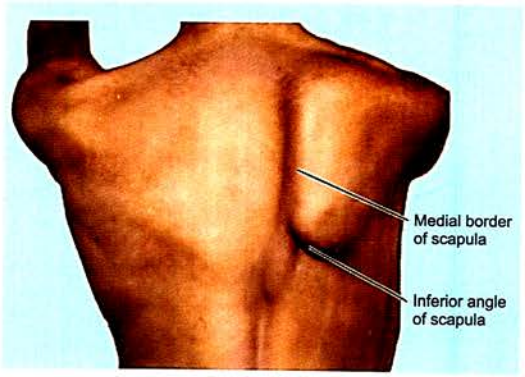
Circumpennate muscle: Tibialis Ant. muscle



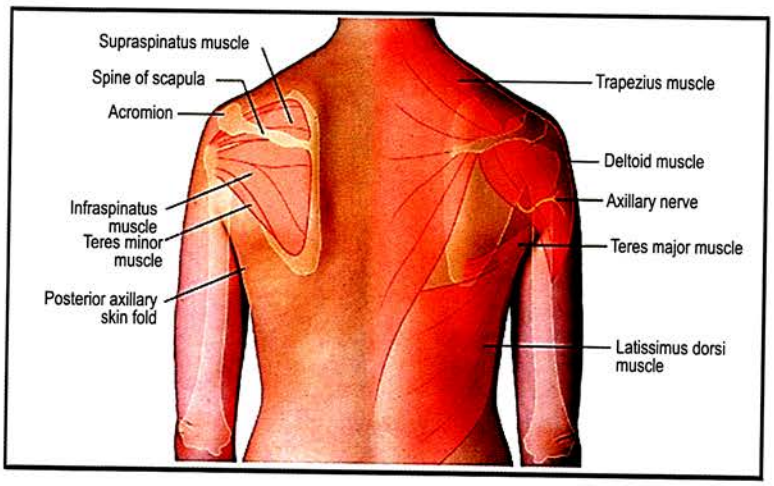


Serratus Anterior muscle

Origin: upper & ribs, lat. Surface
Insertion: Medial border of scapula.
Action: Protraction of scapula
Paralysis of S. anterior muscle causes
↓
Winging of scapula (medial border prominent)

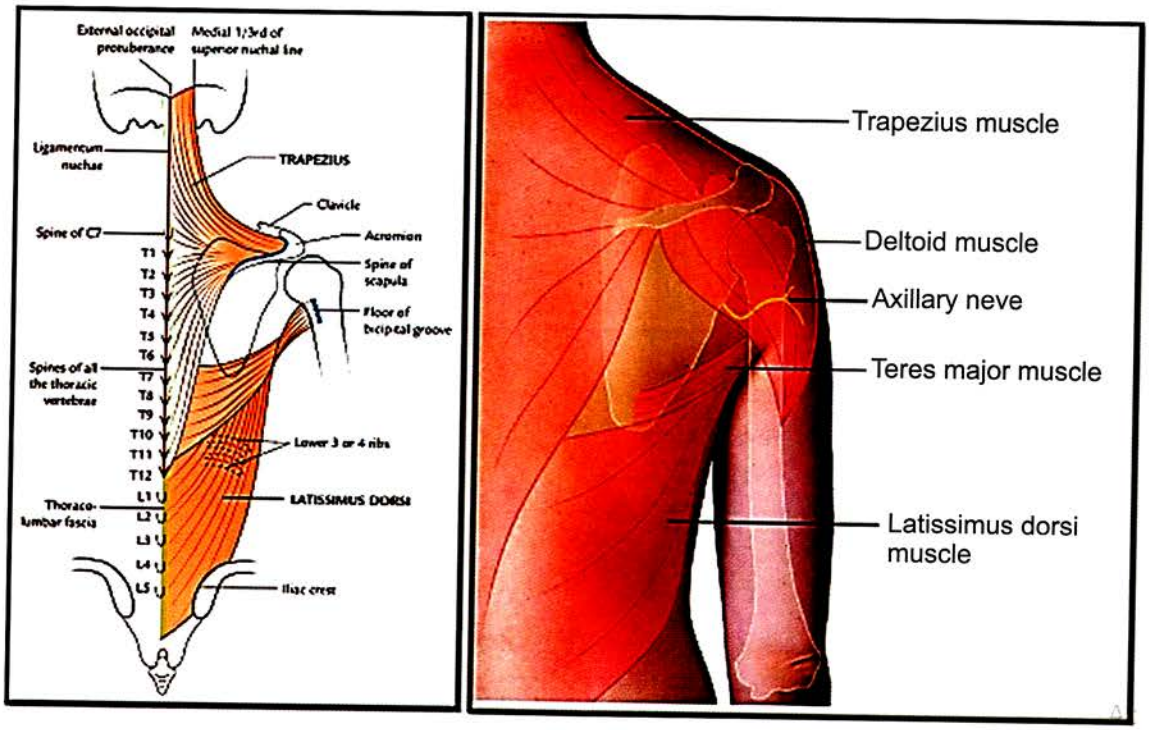


Trapezius muscle:
Triangular muscle:
Origin
→ Occipital bone
→ Spine of cervical thoracic vertebra
Insertion: spine of scapula – sup. border
Action: Elevation/ shrugging of shoulder
N. Supply : Spinal accessory nerve.



L. Dorsi muscle
Origin:
→ Lower thoracic & lumbar spine
→ Thoracolumbar fascia
→ Hip bone (iliac crest)
→ Inf. angle of scapula
Insertion:
→ In a spiral fashion (180) into floor of bicipital groove, ant on humerus.

Deltoid Muscle



Origin

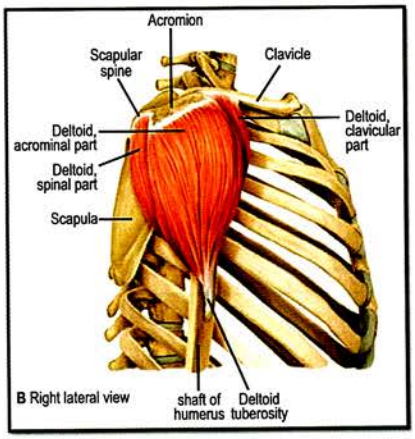
→ Lower border of spine of scapula
→ Outer border of acromion process
→ Ant. surface of clavicle bone

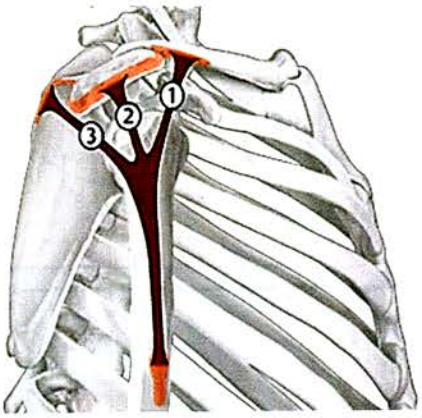
Runs Parallel to Trapezius muscle

Insertion: Deltoid tuberosity on shaft of humerus.

Action: Elevation of upper limb shoulder ABDUCTION.

N. Supply: Axillary Nerve





SIT muscle

S → Supraspinatus's
I → Infraspinatus
T → T. Minor

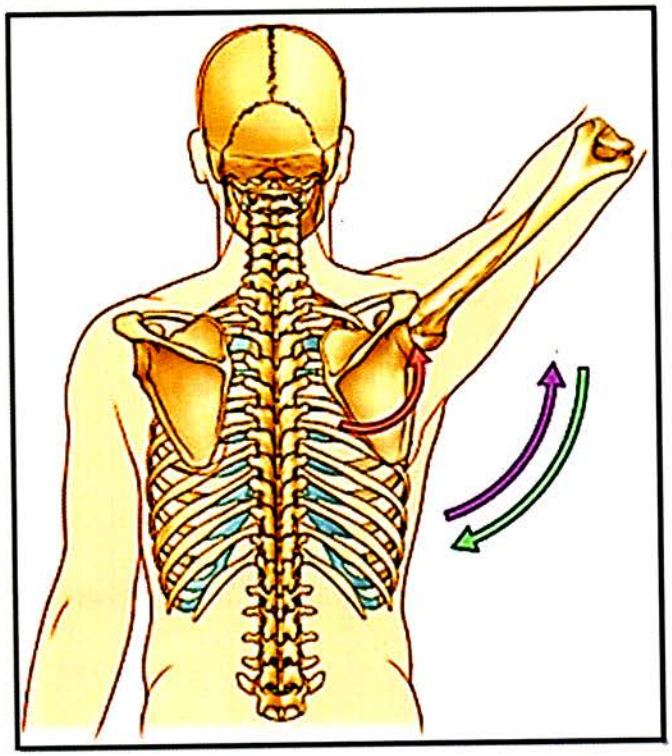
Origin: SIT muscle arise from dorsal surface of scapula

Insertion: Greater tubercle of humerus.

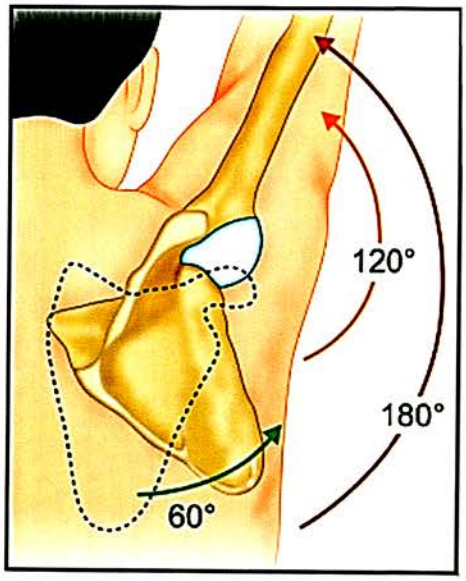
Action

→ Contribute to musculotendinous rotator cuff
→ Stabilizes shoulder it postero-superiorly

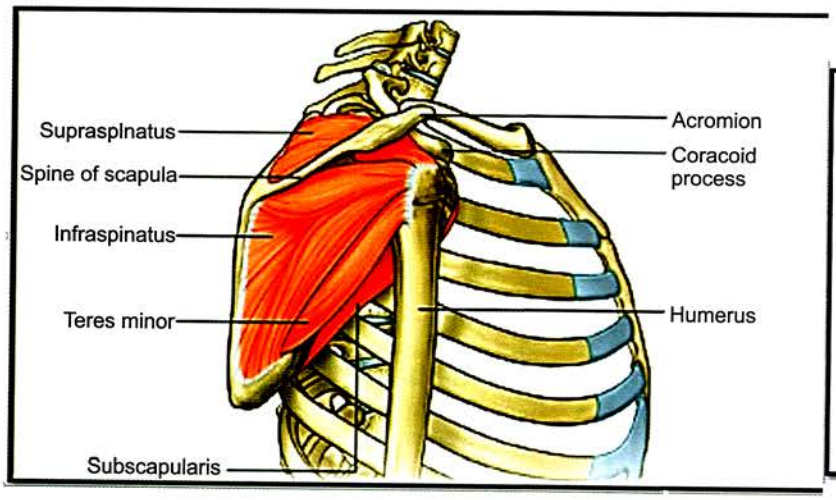
Overhead abduction:

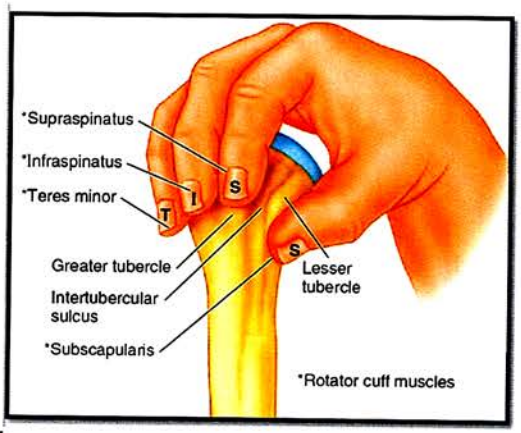


→ S. Ant & Trapezius muscle → Cause shoulder abduction & lateral rotation of scapula.
→ S. ant. pulls scapula forward (protraction of scapula)
→ Trapezius & rhomboid muscle pull scapula backwards.



MUSCLE	Arm abduction DEGREE	NERVE
Supraspinatus	0°-15°	Suprascapular
Deltoid	15°-100°	Axillary
Trapezius	>90°	Accessory
Serratus Anterior	>100°	Long Thoracic





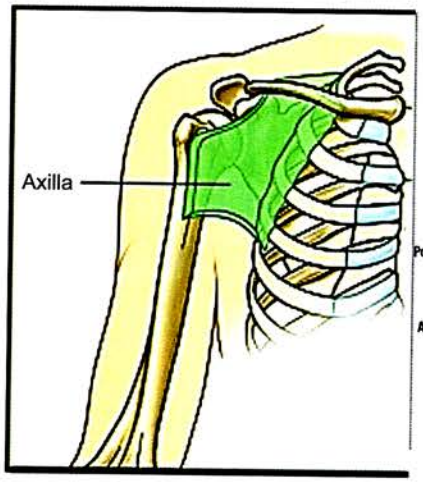
Rotator cuff:

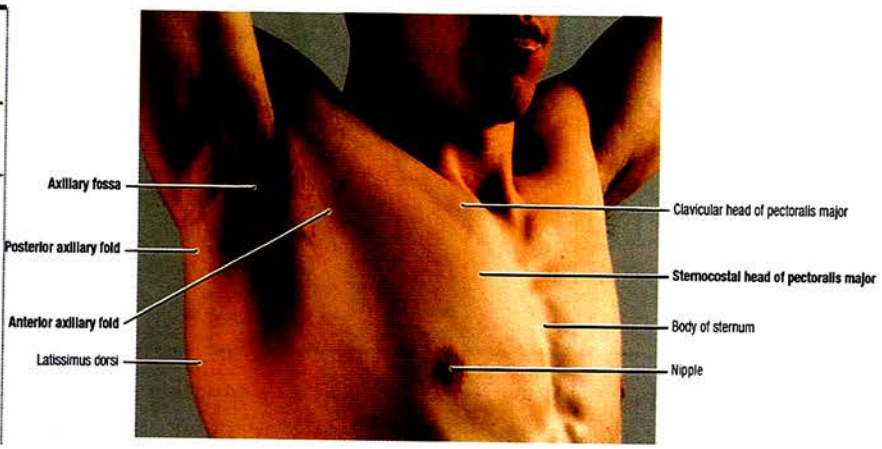
4 muscles

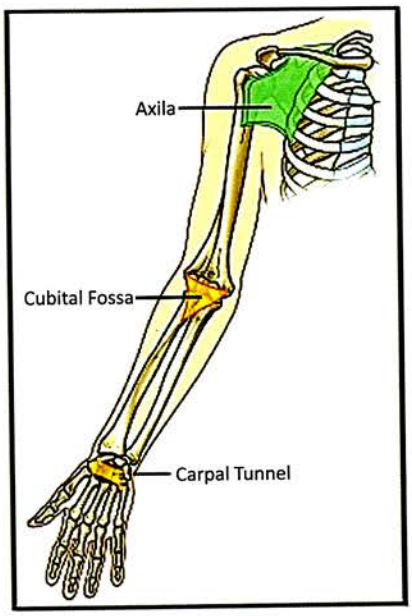
On greater tubercle → SIT muscles

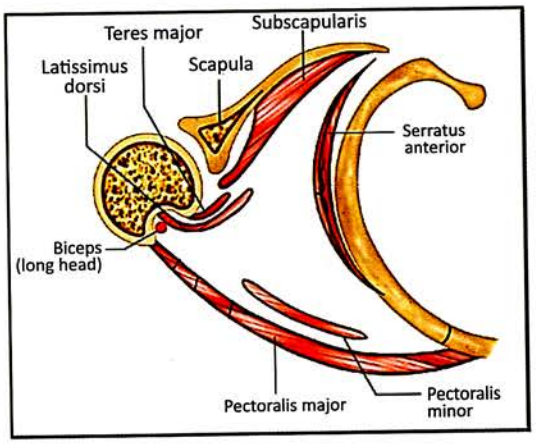
Anteriorly (on lesser tubercle) → Subscapularis (aka forgotten muscle)

Function: Stabilize shoulder joint. Posterosuperiorly









Transverse section of Axilla

- Humerus → Laterally
- Ribs → Medially
- Scapula → Posteriorly

Contents of Axilla

1. **Axillary sheath containing**

→ Axillary A

→ 3 Cords of Brachial plexus

2. **Axillary vein lying outside Axillary sheath**

Scapular Spaces

I) **Quadrangular space**

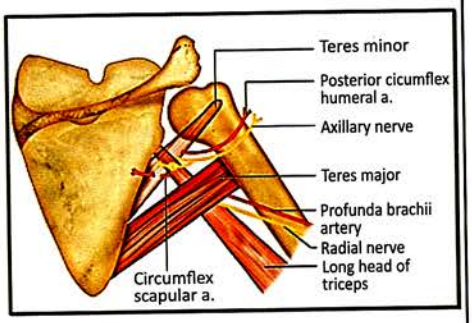
Sup. → Teres minor

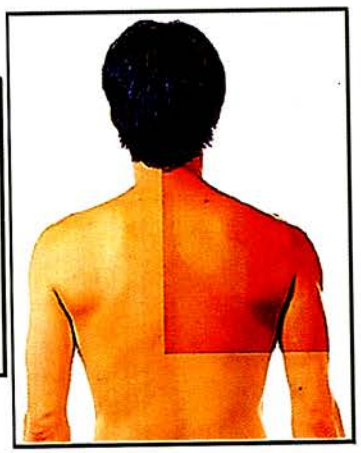
Inf. → Teres major

Med. → Long head of Triceps

Lat. → Surgical neck of humerus

Contents → Axillary nerve, PCHA (Post. Circumflex humeral artery)





ii) **Lower Triangular space:**

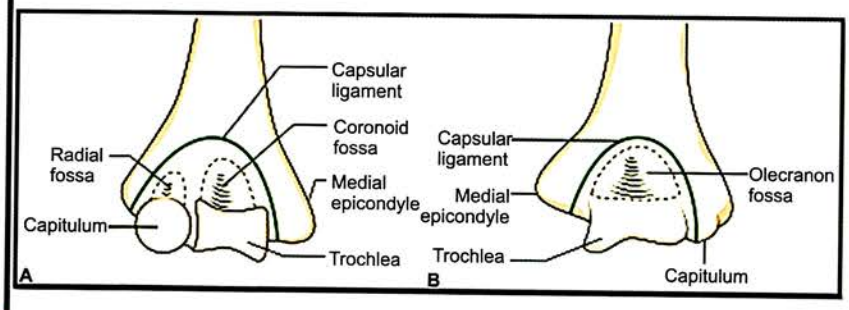
Boundaries

→ Long head of Triceps

→ Teres major

→ Mid-shaft of humerus

Contents: Radial Nerve (Runs in Radial groove along with profunda Brachii artery)



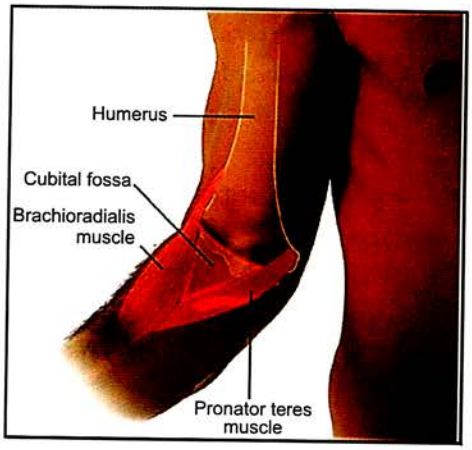
Lower End of Humerus

→ Pressure epiphysis lies inside the capsule
→ Traction epiphysis lies extracapsular
→ Common flexor origin occurs @ medial epicondyle
→ Medial epicondylitis → Causes golfer's elbow
→ Common extensor origin occurs @ ant. Surface of lateral epicondyle.
Lateral epicondylitis → causes **Tennis elbow**

Cubital fossa

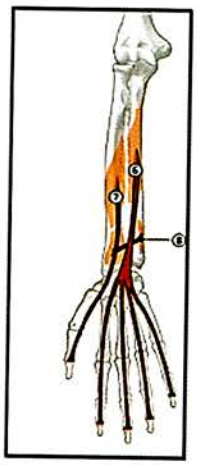
Boundaries:

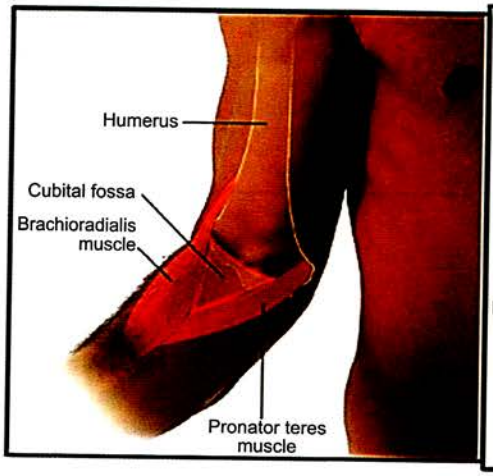
Laterally: Brachioradialis (from supra condylar line)
Medially: Pronator teres (Arising from common flexor origin)
Base: Imaginary line connecting 2 epicondyles
Floor: Supinator muscle
Roof: Bicipital aponeurosis & skin

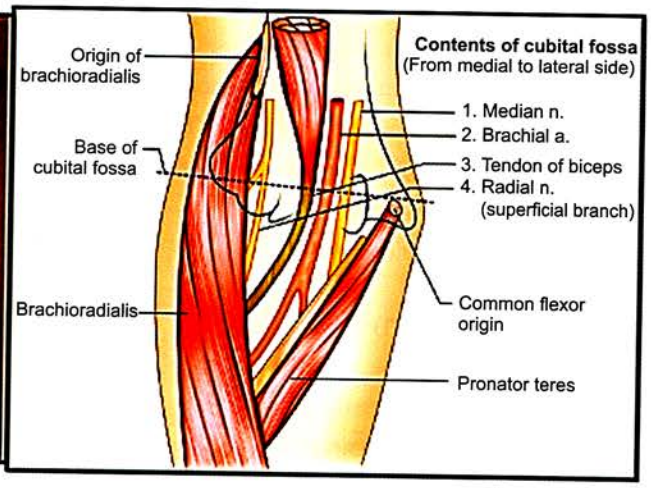


Contents of Cubital fossa:

Radial nerve → Biceps Brachii → Brachial artery → Median artery Nerve
(Lateral) ⟶ (Medial)



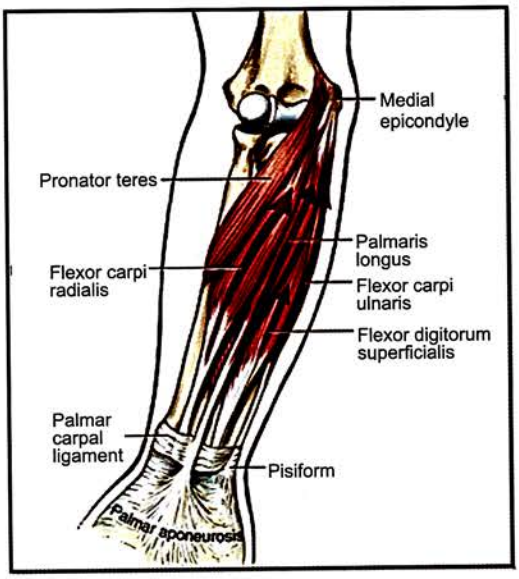




Muscle of Ant. forearm

Superficial muscles

→ Pronator teres
→ Flexor Carpi Radialis (FCR)
→ Palmaris axis longus (forms Palmar aponeurosis)
→ Flexor digitorum superficialies (FDS)
↓ flexion of digits
→ Flexor carpi Ulnaris (inserts @ pisciform bone)



Deep muscles

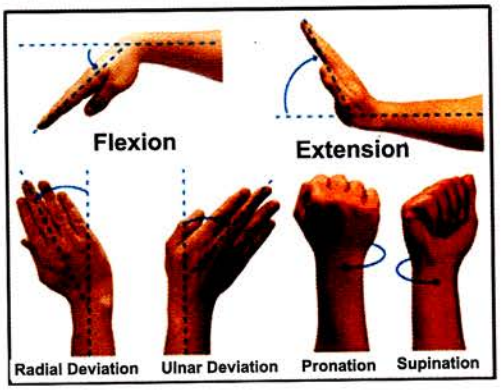
→ Flexor pollicis longus (flexes thumb)
→ Flexor digitorum profundus (flex 4 fingers)
→ Pronator quadratus / Causes pronation

Muscles & their actions at wrist Joint.

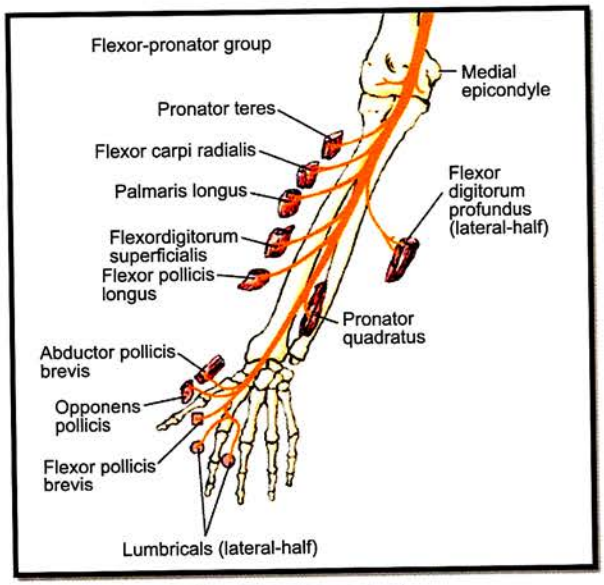
Flexion:

→ Flexor carpi radialis
→ Flexor carpi ulnaris
→ Flexor digitorum superficialis (FDS)
→ Flexor Digitorum Profundus (FDP)
→ Palmaris Longus

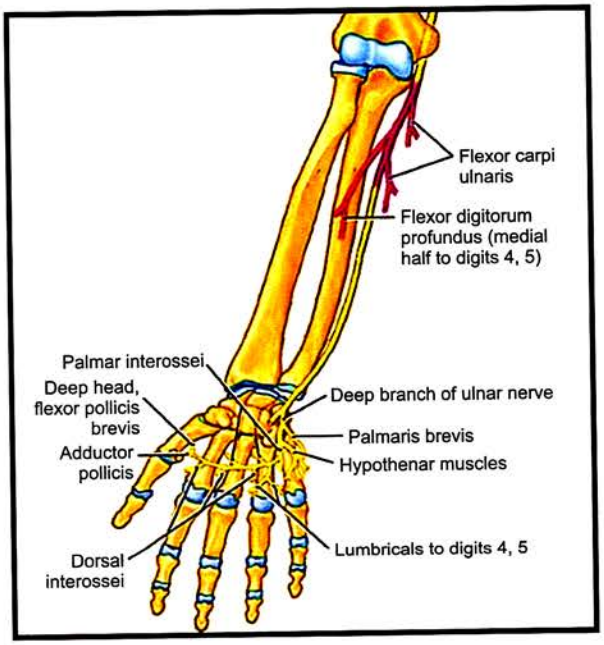
Radial deviation: Flexor carpi radialis (FCR)
Ulnar deviation: Flexor Carpi Ulnaris (FCU)
Supination: Supinator muscle, Biceps brachii
Pronation: Pronator teres, Pronator quadratus



Extension: Posterior extensors of forearm



Median Nerve

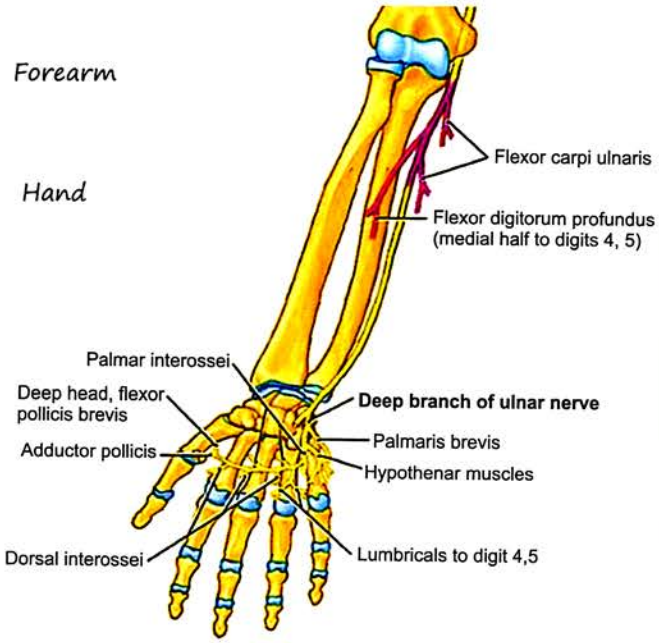


Ulnar Nerve

Nerve supply of forearm:

i) Muscles supplied by Ulnar N

- → Flexor carpi ulnaris } Forearm
- → Medial half of flexor digitorum profundus (FDP) }
- → Hypothenar muscles } Hand
- → Palmaris Brevis
- → All interossei (Palmar & Dorsal)
- → Adductor pollicis }

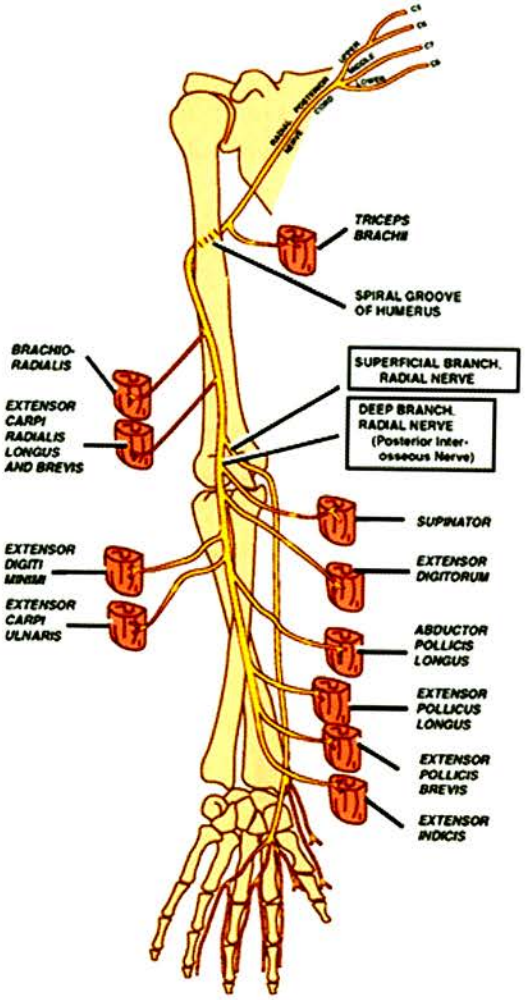


ii) Muscles supplied by Radial Nerve

- → Triceps } Radial groove
- → Anconeus }
- → Branchio Radialis } Level of humerus sh
- → Extensor carpi radialis longus }

Radial N Divides into 2 branches

- → Cutaneous Branch → (Supplies dorsum of hand 3½ fingers, without nail beds
- → Motor Branch aka (Posterior Interosseous Nerve) (Supplies muscle of post. Forearm ED, EPB) Abductor pollicis longus



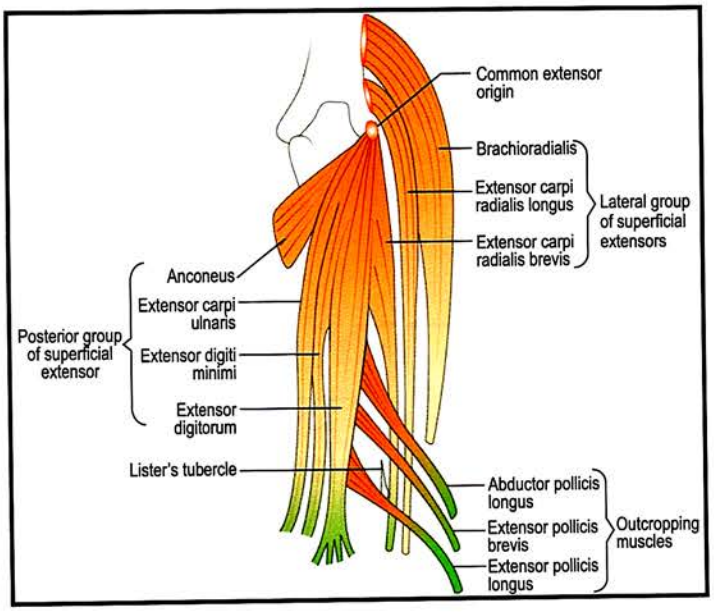
Muscles of Posterior forearm

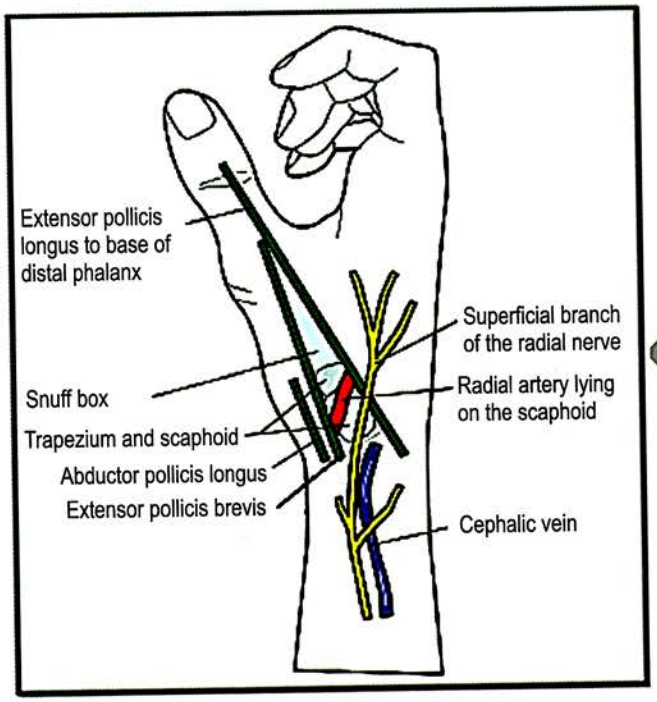
i) Superficial extensors – Posterior group

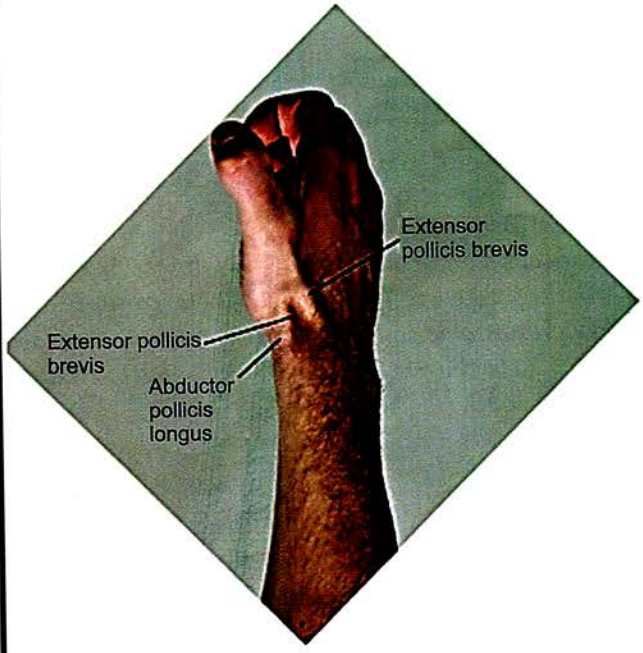
- → Extensor carpi ulnaris (ECU)
- → Extensor digiti minimi (EDM)
- → Extensor digitorum

ii) **Superficial extensor – lateral group**
- → Brachio radialis
- → Extensor carpi Radialis longus (ERL)
- → Extensor carpi Radialis brevis (ECRB)

iii) **Muscle forming boundaries of Anat. Snuff box**
- → Abductor pollicis longus
- → Extensor pollicis brevis
- → Extensor Pollicis longus







Anatomical Snuff box

→ It is bounded antero-laterally by extensor pollicis brevis
Abductor Pollicis longus

Both these muscles get inflamed in Tenosynovitis which leads to "De quervain's test" positive.

Floor: scaphoid bone

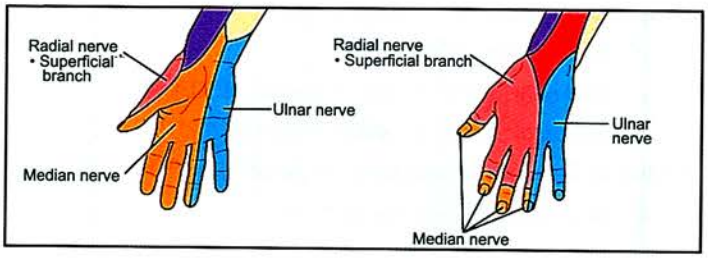
Fracture of scaphoid bone causes tenderness in anatomical snuff box.

Content: Radial Artery

Roof: Cephalic Vein

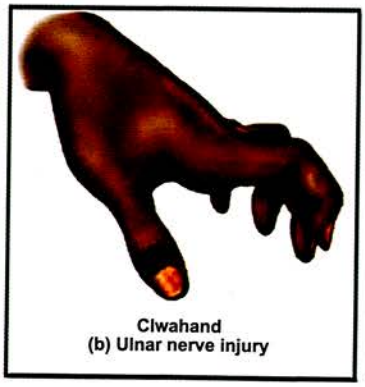
Superficial branch of Radial nerve (supplies dorsum of hand)

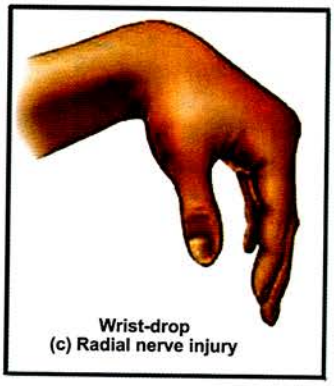
Cutaneous supply of hand:
Skin on ant. 3 1/2 fingers → median nerve along with nail beds on dorsum
Skin on 3



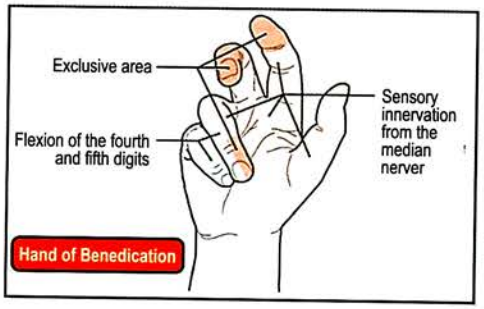
Ulnar Nerve Injuries


"Hand of benedication"
(a) Median nerve injury in elbow region

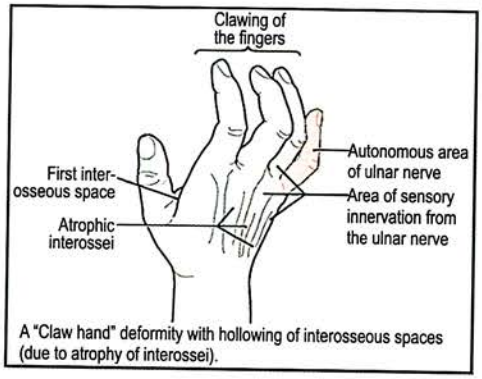

Clwahand
(b) Ulnar nerve injury


Wrist-drop
(c) Radial nerve injury

Hand of Benediction
Cutaneous supply of ventral 3 1/2 finger & nail beds is lost. Patient is asked to make a fist. The area supplied by median nerve is not able to held properly due to compromise of FDS & FDP muscle thumb can't fold due to loss of flexor pollicis longus.

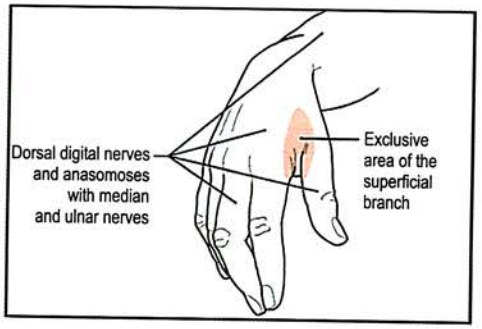


Claw hand
More specifically ulnar claw hand
→ Medial 2 fingers can't fold
→ Hypertension @ MCP joint.
There is compromise of lumbricals interossei (supplied by ulnar nerve). Therefore forearm muscles become more powerful (ext. digitorum posteriorly & FDP. Anteriorly)
This leads to flexion of ant. pharyngeal joint.
Sensory loss of 1 1/2 fingers on dorsum & ventral side both.



A "Claw hand" deformity with hollowing of interosseous spaces (due to atrophy of interossei).

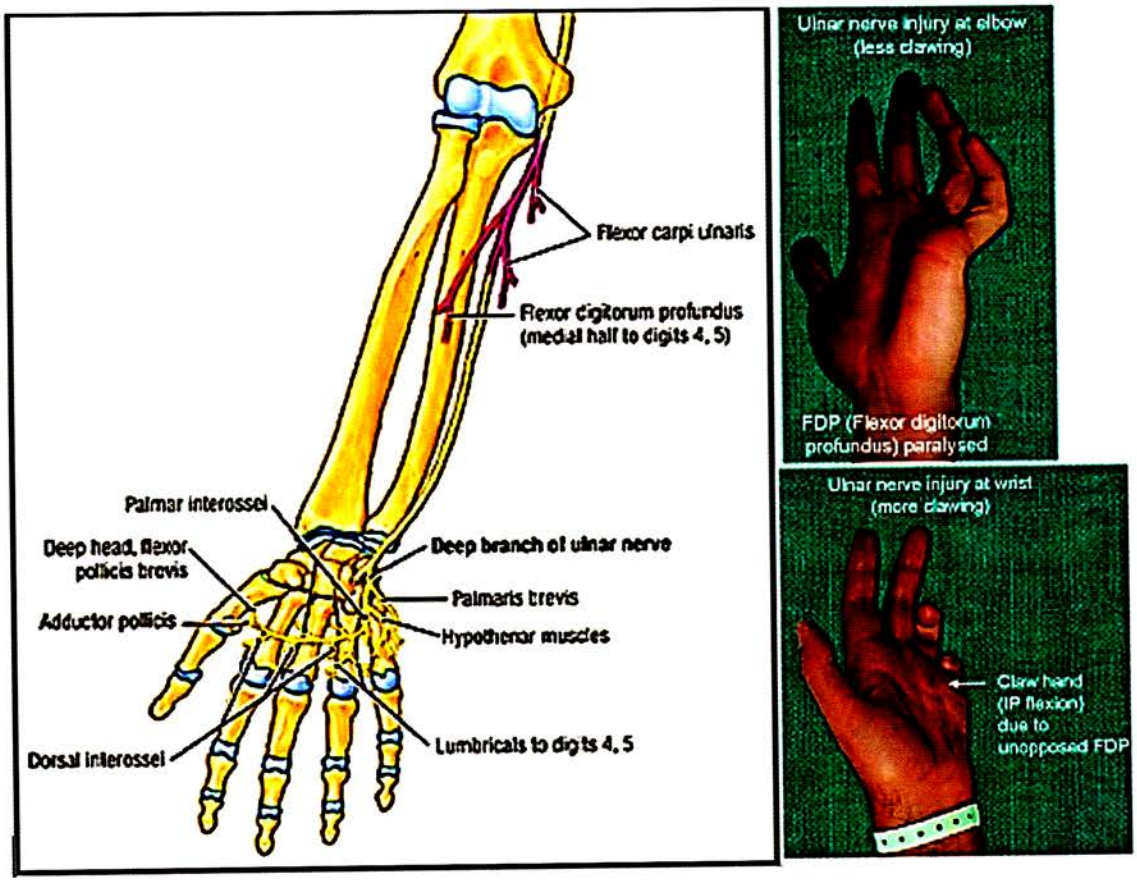
Note: Nail beds are spared (supplied by median nerve)
Radial nerve injury leads to "Wrist Drop"
→ There is loss of wrist extension, loss of finger extension at MCP joint.
→ But inter pharyngeal extension is still possible d/t lumbricals interossei.



Ulnar Paradox

Ulnar Nerve damaged at higher level → Causes less clawing

Ulnar Nerve damaged at lower level → More clawing



In wrist injury, there is paralysis of lumbar interossei, but flexor digitorum profundus muscle is spared which causes powerful contraction out Interphalangeal joint. It leading to more severe claw hand. Whereas in high ulnar nerve injury, the FDP muscle is also paralysed, which causes less clawing.

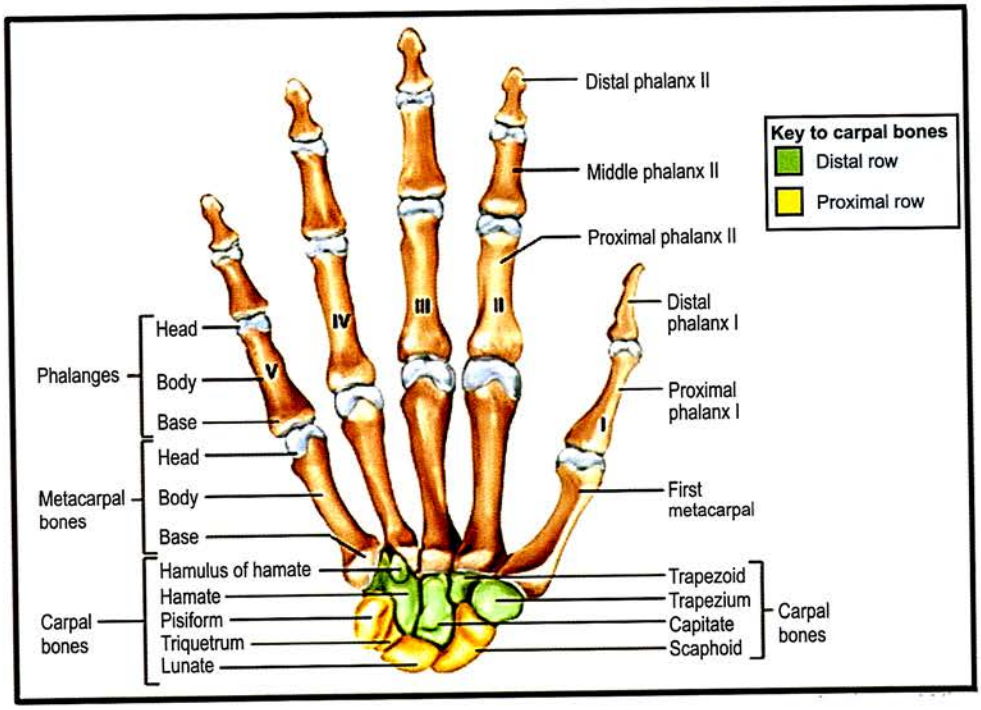
Carpal Bones

SHE
↓
Scaphoid

Looks
↓
Lunate

Too
↓
Triquetrum

Pretty
↓
Pisiform



Try
↓
Trapezium

To
↓
Trapezoid

Catch
↓
Capitate

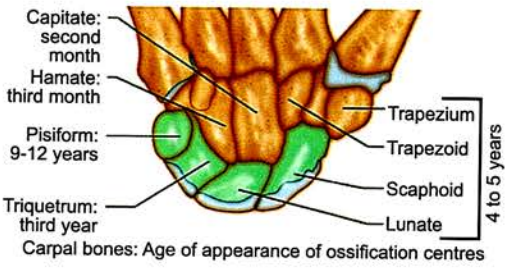
Her
↓
Hamate

Capitate bone

→ Central, largest bone
→ Oldest bone
→ Earliest to start ossification

After birth of baby, ossification begin by 2nd month of birth.

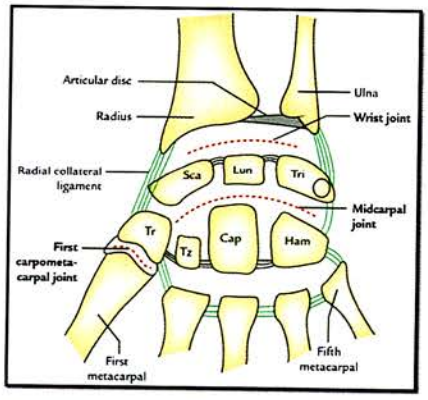
→ **Hamate**: Ossifies by 3 months after birth
→ **Triquetrum**: Ossified by 3rd year after birth
→ Lunate
Scaphoid
Trapezium
Trapezoid
sequence of ossification
Pisiform: ossifies by 9-12 years of birth



Carpal bones: Age of appearance of ossification centres

Wrist Joint Aka Radio carpal joint

Formed by lower end of Radius, Scaphoid, lunate, triquetrum bone
There is no participation of ulnar bone. It is separated by articular Disc.
The first Carpometacarpal joint is a saddle joint for the movement of Thumb opposition.
It is joint between base of 1st metacarpal and Trapezium bone.



Carpal Tunnel Syndrome

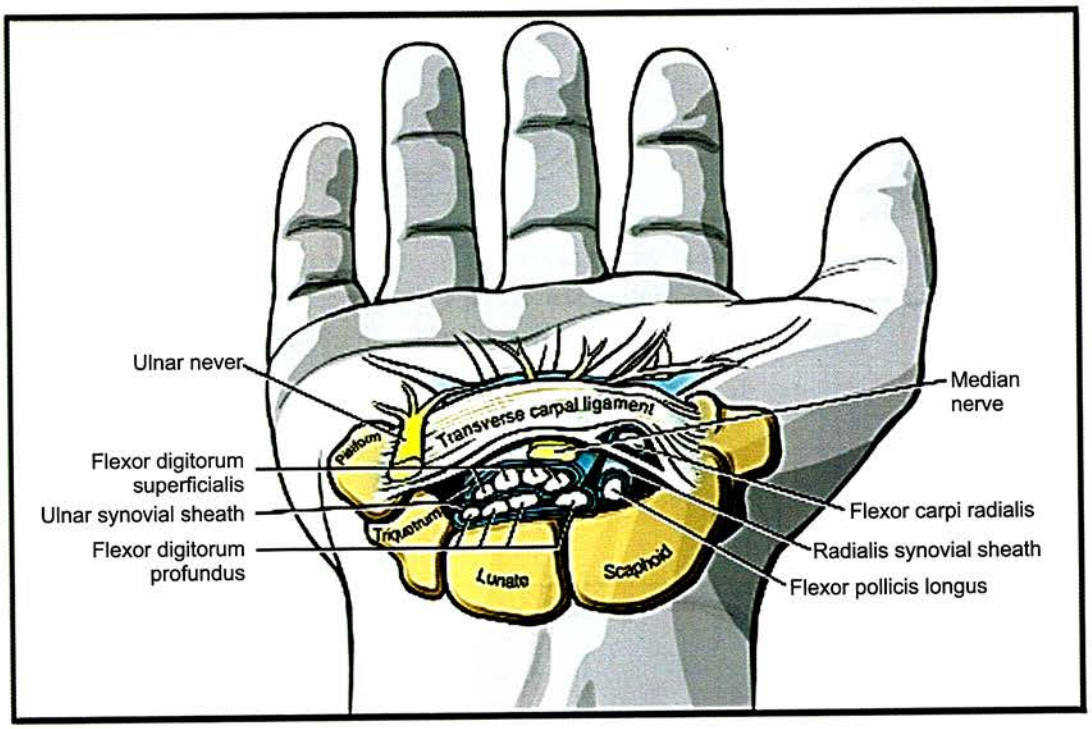
There are 8 carpal bones making tunnel by a bridge of flexor retinaculum.

There are 9 flexor tendons passing under flexor retinaculum along with Median Nerve.

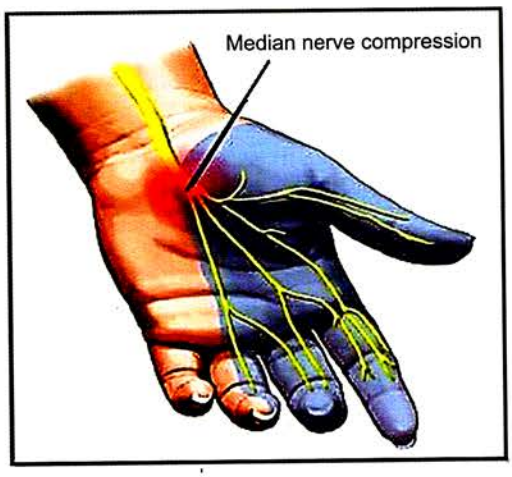
(i.e. 4 tendons of FDS, 4 tendons of FDP, 1 tendon of FPL)

Overuse of these tendons (e.g. Typist Job) can be inflamed which compresses median nerve leading to carpal tunnel syndrome

Ulnar nerve is not affected because it passes superficial to flexor retinaculum



→ Median Nerve injury in carpal Tunnel syndrome causes tingling in 3 1/2 fingers including Nail bed.

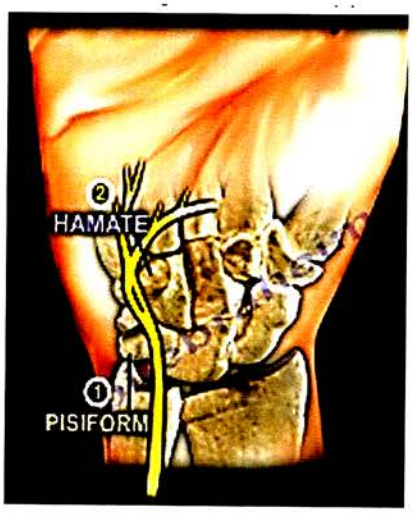


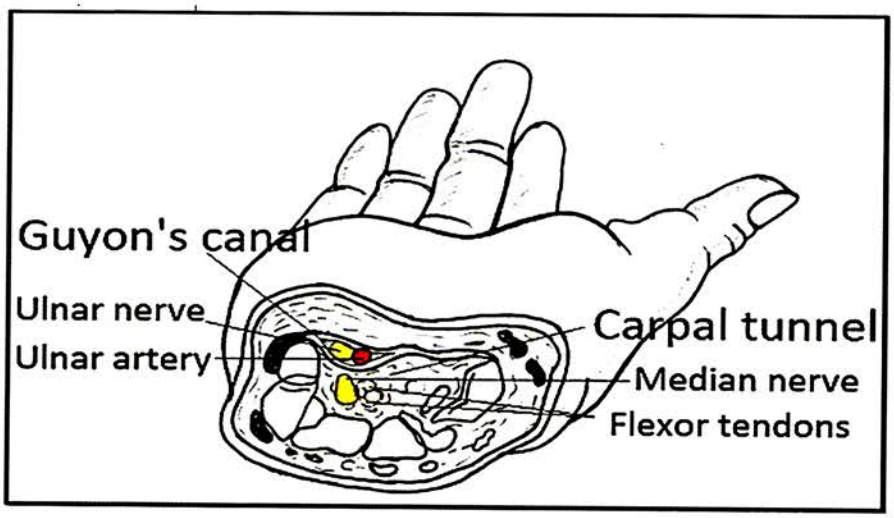
Patient present with "Ape hand deformity" thenar muscles atrophy occurs due to compression of median nerve in carpal tunnel.

→ Adduction deformity occurs.

→ Pen Test +ve

→ Difficulty in Thumb Opposition (Ape-hand)



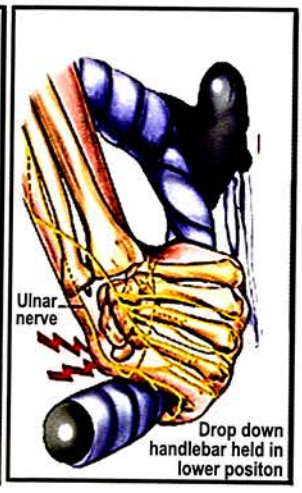


Ulnar Nerve Passes through Guyon's Canal passes superficially, goes medial to Hamate bone & lateral to Pisiform bone. It can be compressed here causing sensory & motor problems

Carpal Tunnel syndrome compromises median nerve whereas Guyon's canal will causes ulnar Tunnel syndrome

Ulnar Tunnel Syndrome

It can happen in handle bar injuries chronic compression of ulnar nerve can lead to sensory loss in 1 1/2 fingers along with motor problems



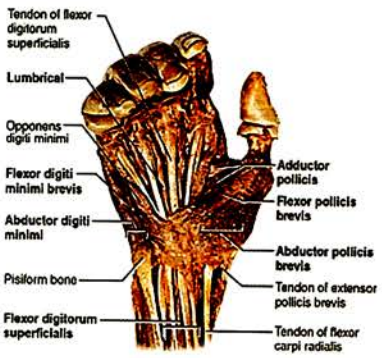
Thenar muscles

- → Flexor pollicis brevis
- → Abductor pollicis brevis
- → Opponens pollicis

Hypothenar muscles

- → Flexor Digiti minimi
- → Abductor digiti minimi

Lumbricals (originating from tendons of FDP, arising laterally from each tendon)

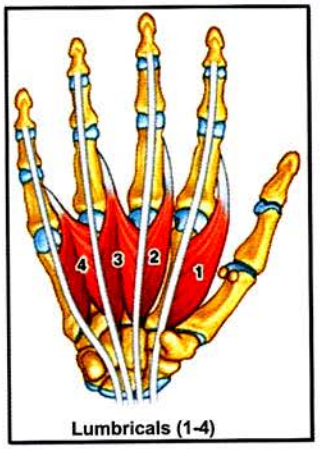


Note: Adductor pollicis is a deep muscle acting on the thumb.

Lumbricals

1 & 2 are unipennate muscles, originate from FDP tendon, laterally & go into dorsum of finger & insert on Dorsal digital expansion. While crossing MCP joint, They cause MCP joint flexion & extension at IPJL.

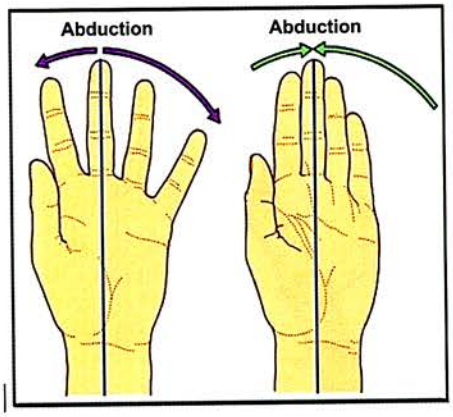
Lumbricals 3 & 4 → bipennate muscles

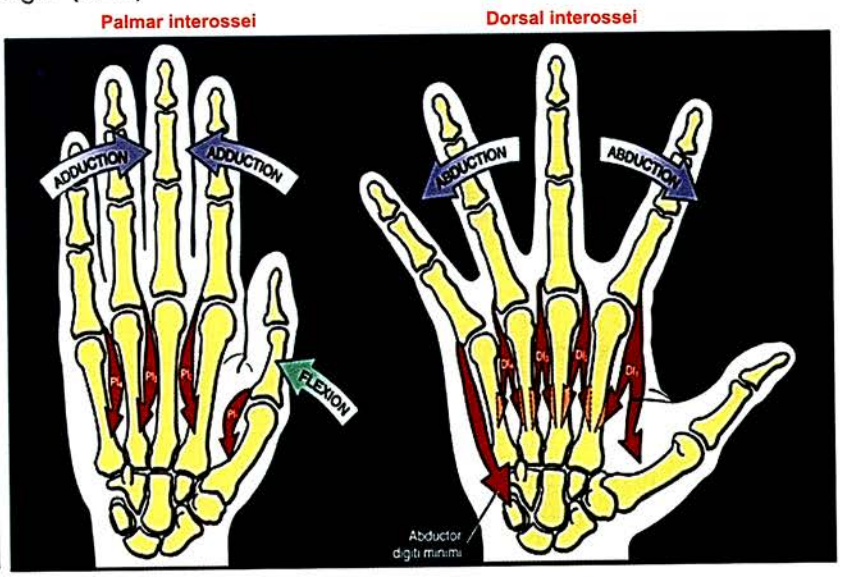


Lumbricals (1-4)

Palmar interossei cause – Adduction of fingers (PAD)

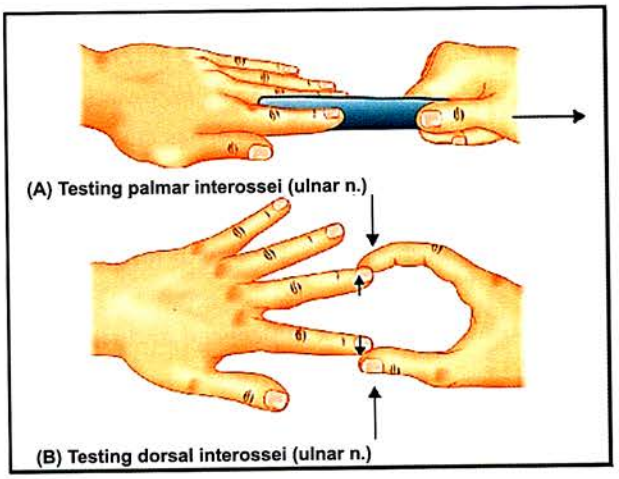
Dorsal interossei cause – Abduction of finger (DAB)





→ To check for palmar interossei → <u>Card test</u> - Hold card between fingers & try to pull the card out .

→ To check for Dorsal interossei: Spread the fingers, put resistance & ask the patient to spread them.



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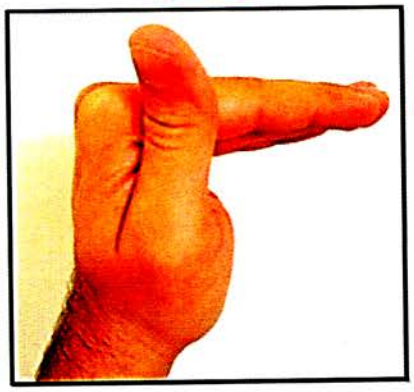
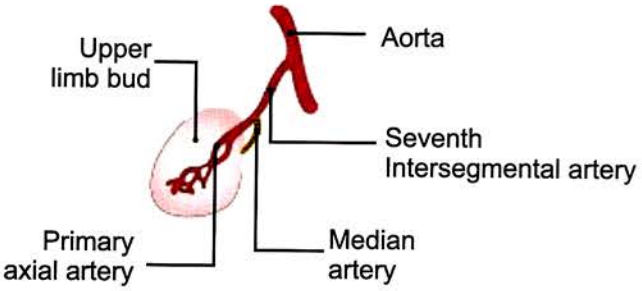
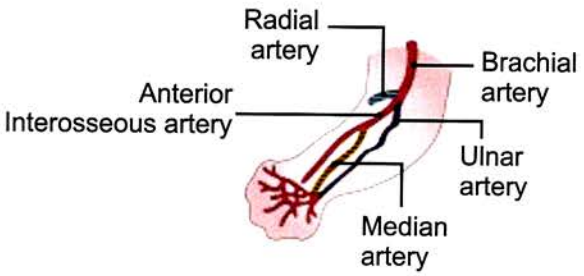


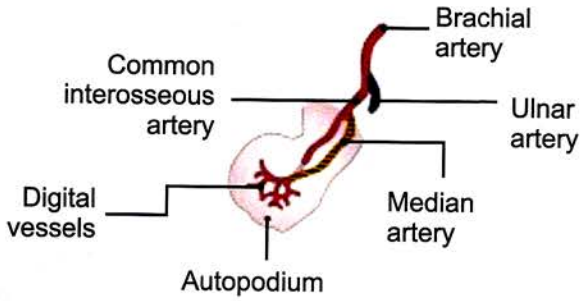
MCP Flexion

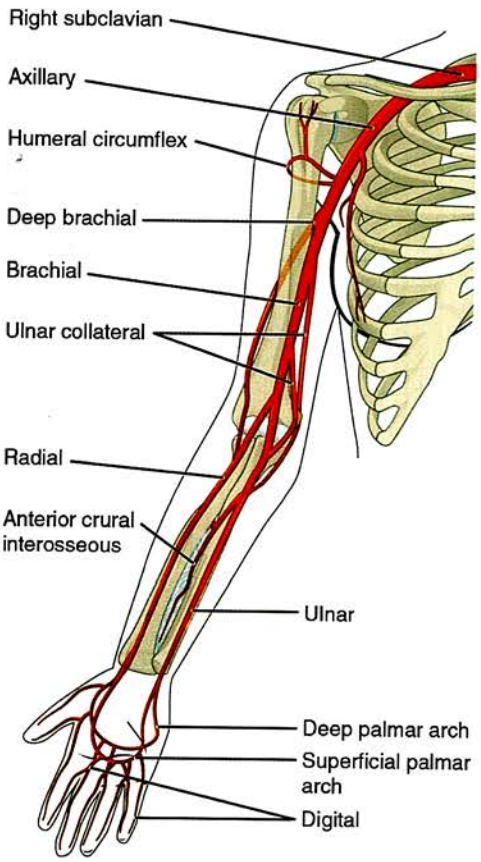
IP Extension

Development









→ *Pre-axial artery towards Radial bone*
→ *Post-axial artery towards Ulnar bone*
→ *Anterior interosseous artery is the Axial artery.*
→ *Subclavian artery passes outer border of 1st rib enters Axilla & becomes Axillary artery which further crosses lower border of teres major to become Brachial Artery.*
→ *Brachial Artery when reaches cubital fossa divides into Radial & Ulnar Artery.*
→ *Ulnar Artery enters Palm to form superficial palmar arch*
→ *Radial Artery enters Palm to form Deep Palmar Arch*

The Anastomoses b/w superficial and deep palmar arches can be checked via "Allen Test".

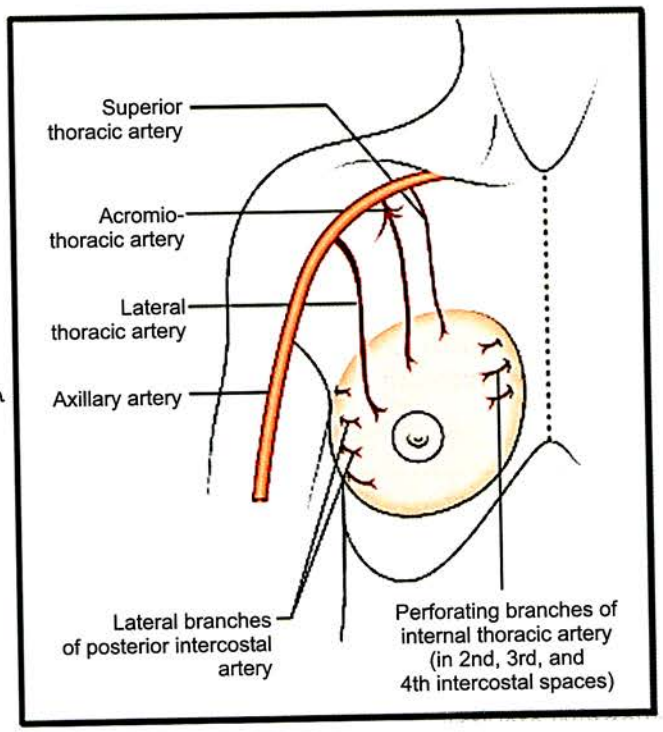
Axillary Artery

Has 3 parts divided by Pectoralis Minor muscle Covering the artery.
1st Part gives 1 branch
2nd Part gives 2 branches
3rd part gives 3 branches
1st Part lies Proximal to P. Minor muscle gives superior thoracic artery
2nd Part branches (lies under cover of P. minor)
→ *Thoracoacromial Artery*

→ Lateral Thoracic A
3rd part Braches (lies distal to P. minor)
→ Ant. Circumflex humeral artery
→ Post Circumflex Humeral (PCHA)
→ Sub scapular Artery
ACHA & PCHA anastomose at the surgical neck of Humerus.

Mammary Gland

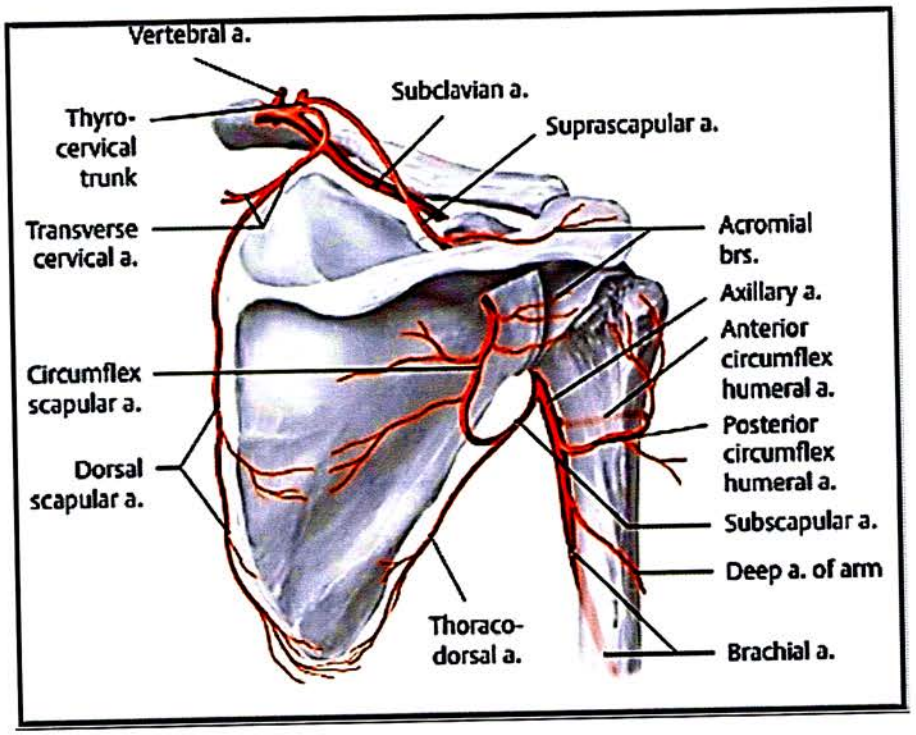
It is highly vascular structure supplied by branches of axillary artery along with Post. Inter costal arteries & internal thoracic arteries running in parasternal region.



Scapular Anastomosis

Arterial supply axillary artery gives a branch – subscapular artery which itself gives a branch k/a circumflex scapular artery. Subscapular Artery then continues as Thoraco dorsal artery then

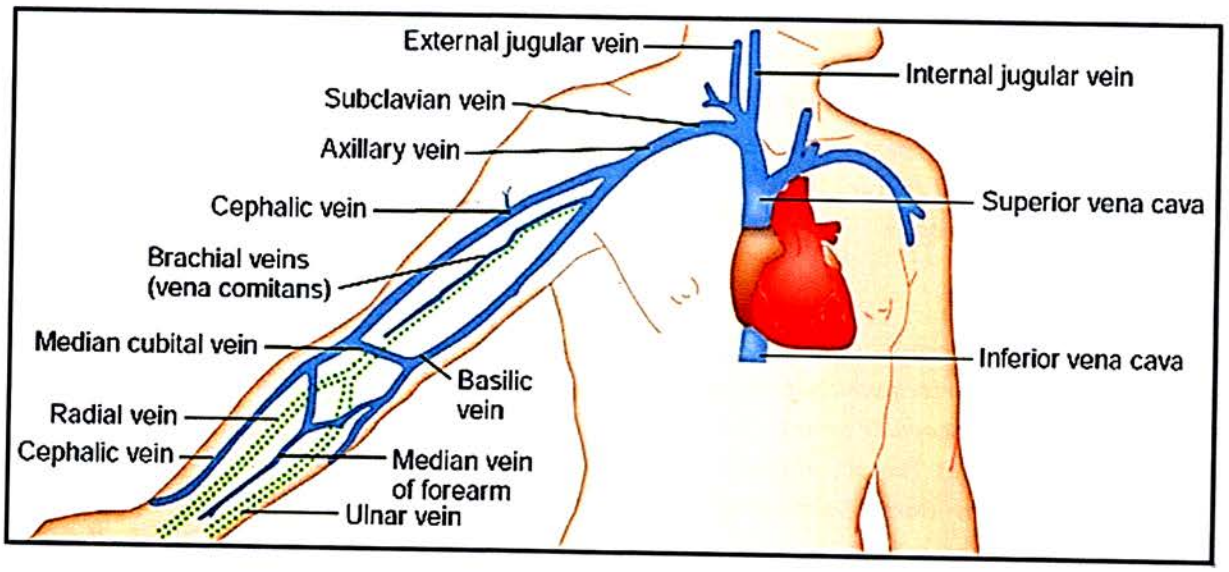
→ It anastomoses with Dorsal Scapular Artery branch of subclavian artery
→ Circumflex scapular artery anastomoses with suprascapular artery (branch of subclavian A) In case there is block in subclavian artery d/t upper limb ischemia this anastomosis can be used to send blood, to upper limb



Venous Drainage:-

Deep Veins

→ Radial vein, Ulnar vein join to form brachial vein which continues as axillary vein. Which then further continues as subclavian vein
Subclavian vein get joined by IJV to form Brachiocephalic vein, which on either side comes to form SVC which finally drains into R.A of heart.



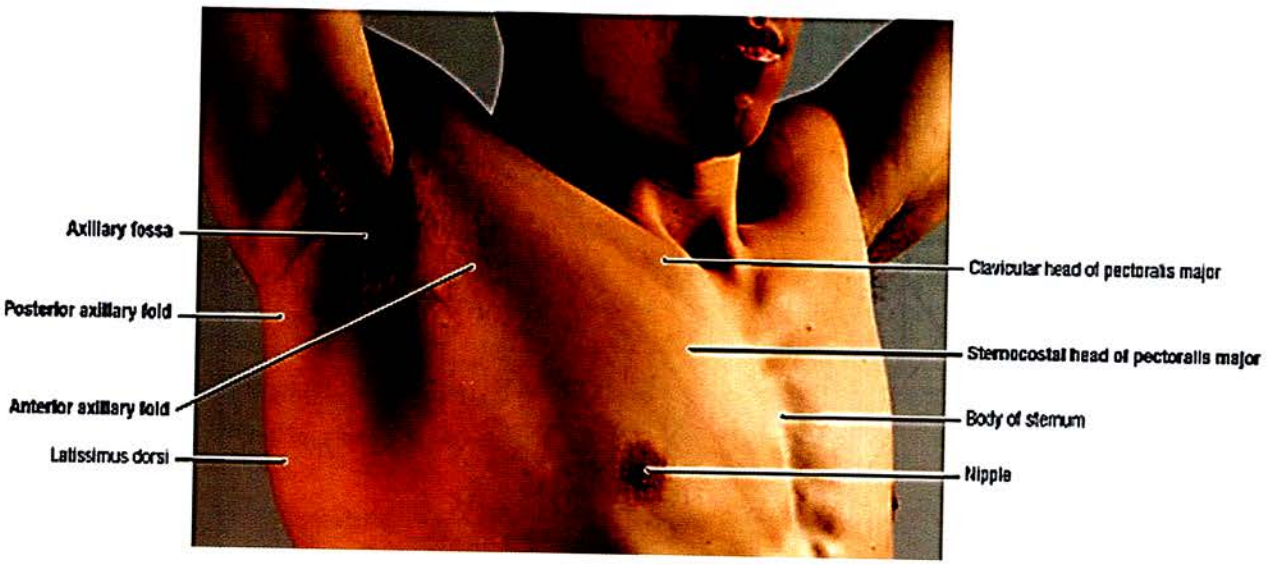
Superficial Veins

→ Lateral/ Cephalic Veins (continuation of Dorsal venous arch) drains into Axillary vein in axilla after piercing Clavipectoral fascia. Cephalic vein lies at the roof of anatomical snuff box.

→ Basilic Vein in forearm drains blood into brachial vein. Communication between Basilic veins & Cephalic veins is median Cubital veins. It is the mostly used for taking venous blood sampling/ Transfusions

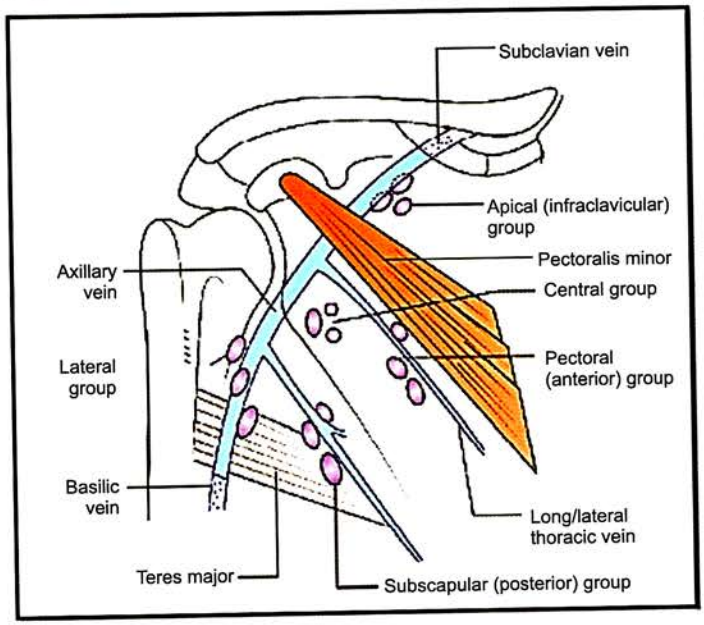
Note: L.N → Lymph nodes

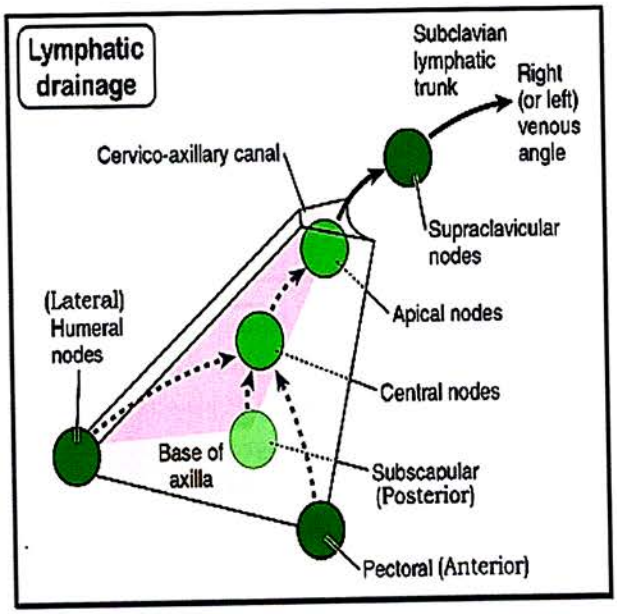
Lymphatic Drainage of upper limb:



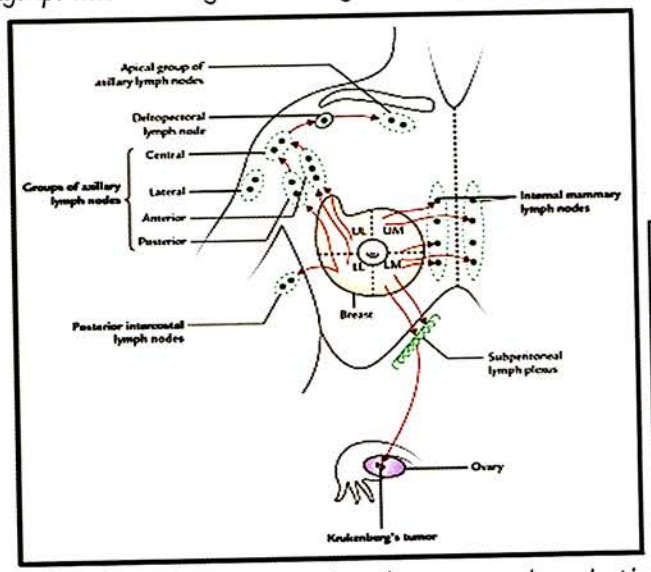
→ Posteriorly, subscapular L.N.s are called posterior axillary L.N.
→ Pectoral lymph nodes are anterior axillary L.N
→ Laterally lat. Axillary lymph nodes are called humeral L.Ns
Three of them drain into central Axillary L.N. which drains into apical L.N
Apical group are terminal L.N.s which drain into Right lymphatic duct (Right side) or Thoracic duct on \ left side.

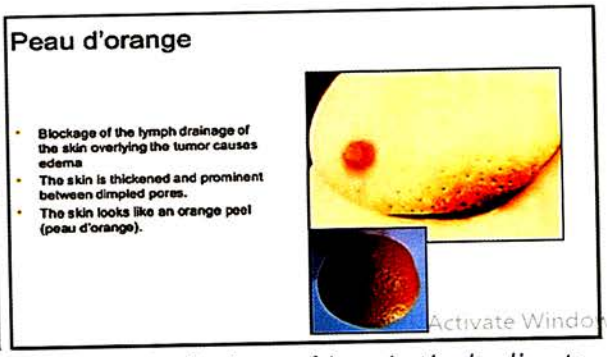
Lymphatic Drainage of Mammary gland





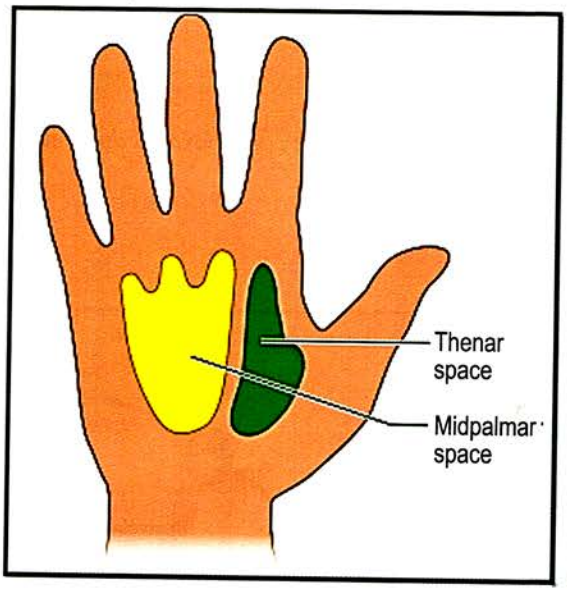
→ 75% of lymph goes into Pectoral (axillary) L.Ns from where it goes into subscapular as well these finally drain into central axillary L.N & Apical L.N from here it goes into supraclavicular L.N & finally Rt. Lymphatic duct (Right side) Or Thoracic duct (On left side)
→ Parasternal Lymphatics can cross midline & cross to other side
→ Lymphatic drainage in Retrograde manner. When goes into ovaries, it is then called **Krukenberg Tumor**

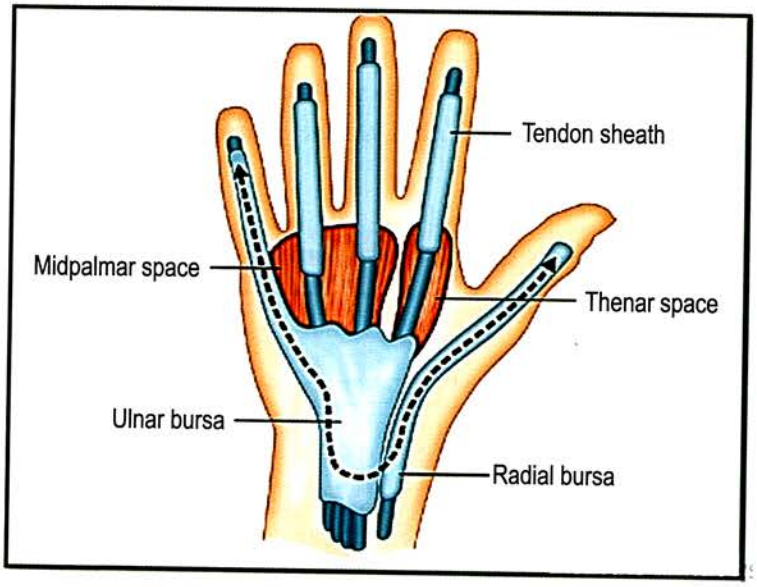




→ Cancerous cells, when invade subcutaneous lymphatics there will be blockage of lymphatics leading to Peau d'orange

Hand spaces





2 types: Thenar Space and Midpalmar space

- → **Radial bursa:** It is the synovial sheath over tendon of FPL.
- → **Ulnar Bursa:** Lies on FDP muscle
- → It is continuous with synovial sheath of litte finger

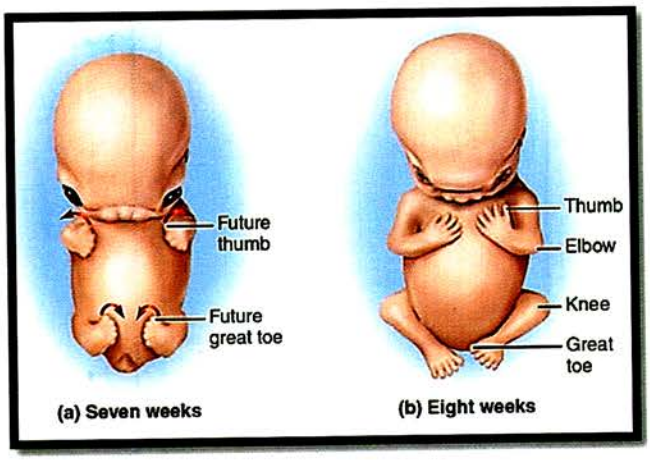
Ulnar & Radial bursae communicate with forearm space of PARONA.

Any infection in these bursae can spread to forearm through these spaces .

Lower limb

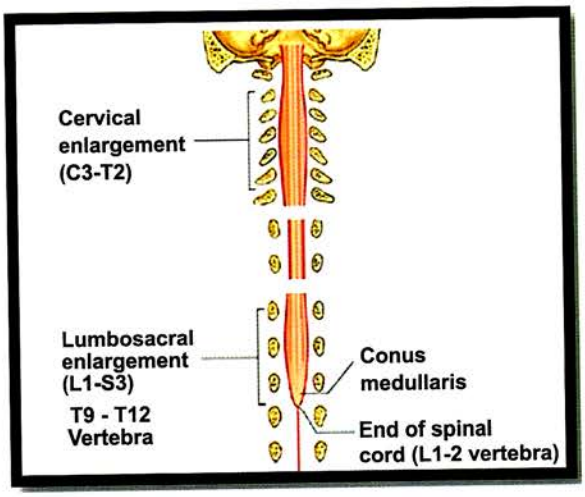
Limb rotation

→ UL rotate 90 degree laterally
Thumb will become lateral
Flexor compartment is anterior
→ LL rotate 90 degree medially
Great toe become medial
Flexor compartment posterior
Anterior compartment is extensor
Hip extension not included



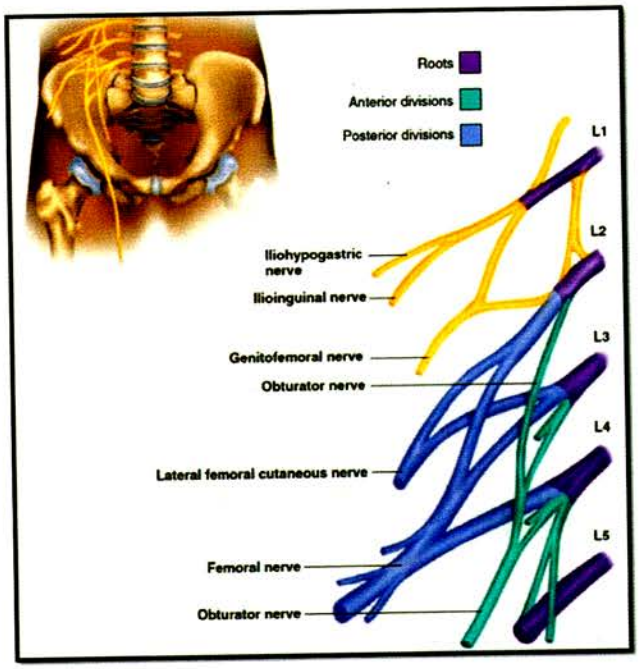
Nerve supply:

Lumbo – sacral enlargement → root value: L-1 to S-3
Eg. Sciatic nerve L4,L5,S1,S2,S3



Lumbo sacral plexus

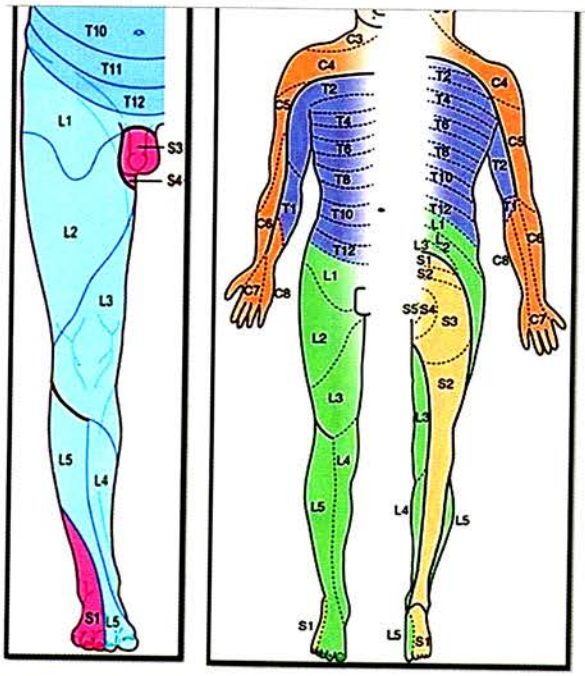
Sciatic nerve
→ Root value → L-4, 5; S-1, 2,3
→ leaves pelvis through the greater sciatic notch & enters the gluteal region & continues in the posterior thigh
→ combined nerve '
Tibial nerve (runs with tibia)
Common fibular nerve (runs with abula)
→ superficial & deep branches



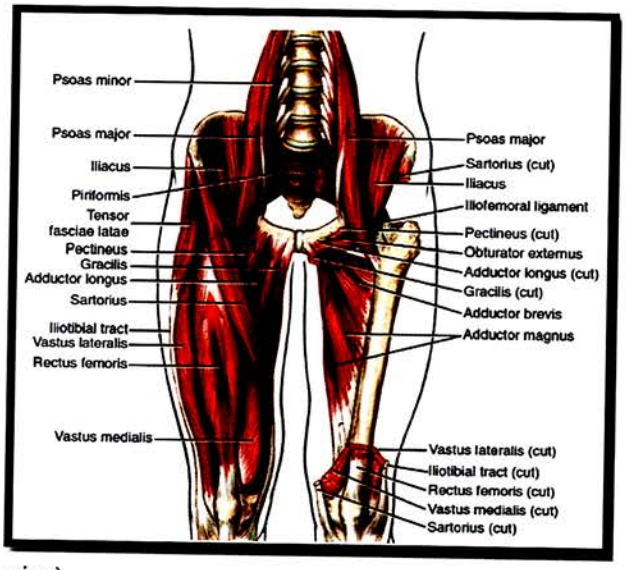
Pudendal nerve → s-2,3,4
Posterior cutaneous nerve of thigh → S-1,2,3
Superior gluteal nerve (L-4,5; S-1)
Inferior gluteal nerve → L-5; S-1,2

Dermatomes

Little toes → S1
Great toe → L5
Lower limb → L1-S1
L1 → inguinal region
S1 → little toe, lateral margin of foot
S-2 post aspect of lower limb.
calf, thigh
S1 → little toe & lateral margin
→ supplied by lateral plantar n (br. of Tibial nerve)



Muscles of the anterior compartment of the thigh (flexors of the hip joint)



Anterior Thigh

Iliac region constitutes a group of three muscles that originate from the lumbar vertebral column (psoas major and minor) and the ilium (iliacus). Psoas major and iliacus are attached together on the femur as flexors of the hip joint and are often considered as a functional unit, iliopsoas. (Chief flexors of hipjoint)

Quadriceps Femoris - (Chief expenfors of knee joint) Rectus femoris and three vasti attach to the base of the patella (a sesamoid bone), continue as the patellar ligament, extending from the patellar apex to the tibial tuberosity. These muscles pull the tibia anterior (knee extension).

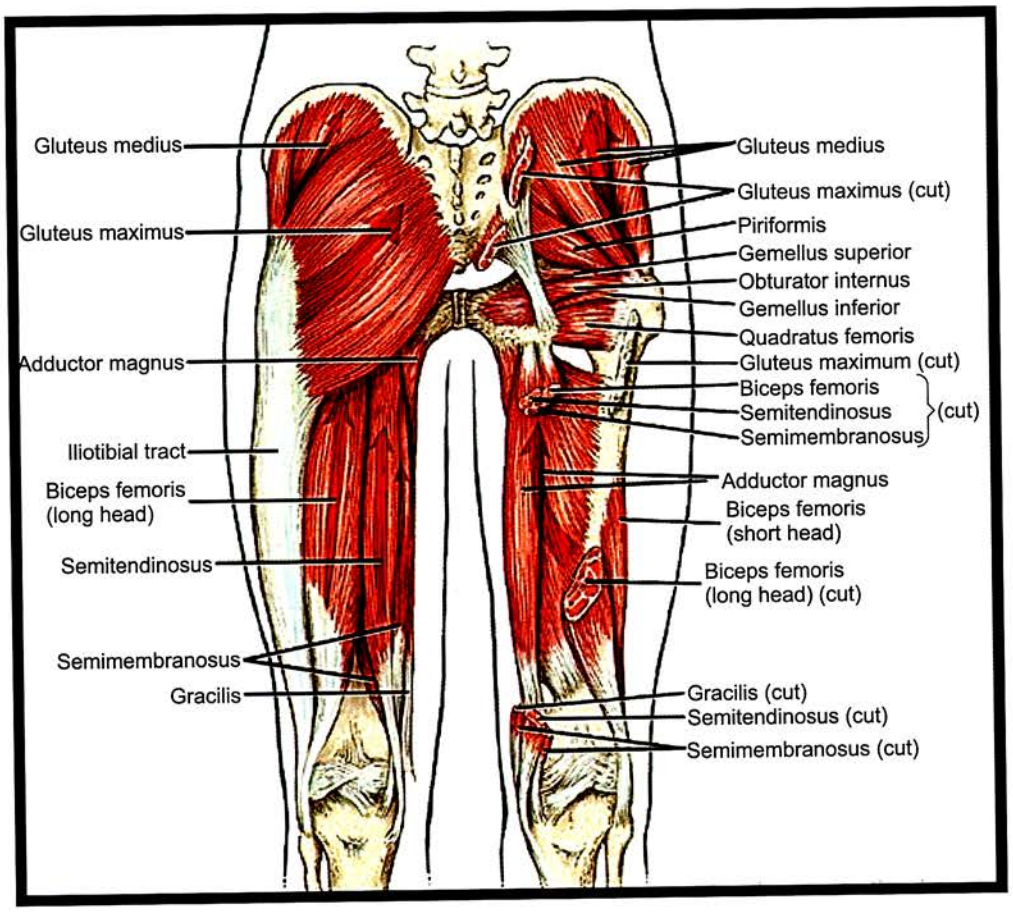
Articularis genus belongs to anterior thigh muscles, retracts the synovial suprapatellar bursa proximally during extension of the leg, presumably to prevent interposition of redundant synovial folds between patella and femur.

Muscles of the Anterior Compartment of the Thigh (Flexors of the Hip Joint)

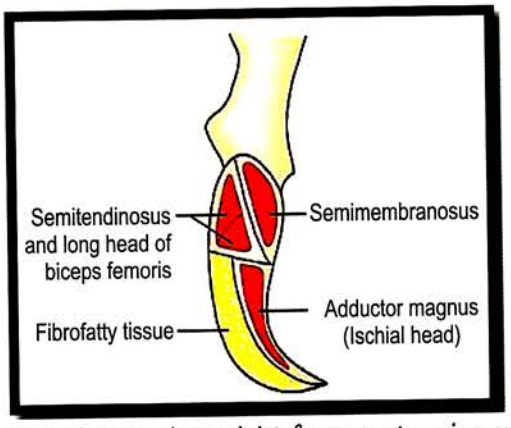
Muscle	Innervation	Action
Pectineus	Femoral nerve (L2, L3)	Adducts and flexes the thigh Assists in medial rotation of the thigh
Psoas major	Anterior rami of L1, L2, L3	Flexes the thigh
Psoas minor	Anterior rami of L1, L2	Flexes the thigh
Iliacus	Femoral nerve (L2, L3)	Flexes the thigh
Sartorius	Femoral nerve (L2, L3)	Flexes, abducts, and laterally rotates the thigh Flexes the leg

Medial Thigh

Muscles of the adductor compartment — gracilis, pectineus, adductor longus, adductor brevis, and adductor magnus have evolved, as their nerve supply suggests, from both flexor and extensor columns.
Obturator externus is a lateral rotator hipjoint



Hamstring Muscles:

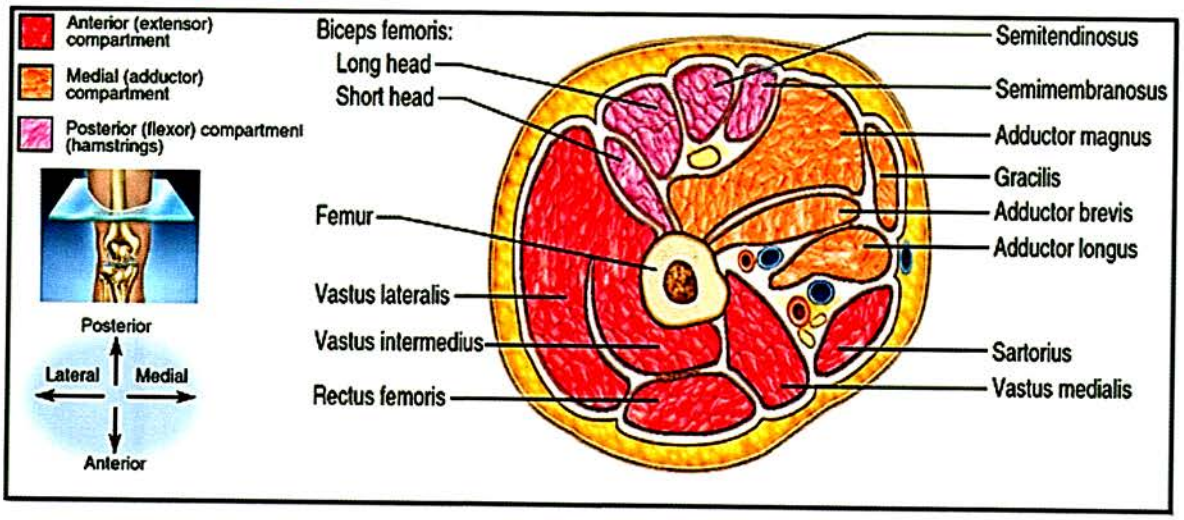


Posterior thigh muscles, biceps femoris, semitendinosus and semimembranosus, are termed the 'hamstrings'.
They cross both hip and knee joints, and integrate extension at the hip with flexion at the knee.
Actions of posterior thigh muscles acting from above, the posterior thigh muscles flex the knee. Acting from below, they extend the hip joint, pulling the trunk upright from a stooping posture against the influence of gravity, biceps femoris being the main agent. When the knee is semi-flexed, biceps femoris can act as a lateral rotator and semimembranosus and semitendinosus as medial rotators of the lower leg on the thigh at the knee. When the hip is extended, biceps femoris is a lateral rotator and semimembranosus and semitendinosus are medial rotators of the thigh.

Muscles of the Posterior Compartment of the Thigh (Extensors of the Hip Joint and Flexors of the Knee Joint)

Muscles	Innervation	Action
Semitendinosus	Tibial part of sciatic nerve (L5, S1, S2)	Extends the thigh Flexes the leg Medially rotates the flexed leg
Semimembranosus	Tibial part of sciatic nerve (L5, S1, S2)	Extends the thigh Flexes the leg Medially rotates the flexed leg
Biceps femoris	Long head: Tibial part of sciatic nerve (L5, S1, S2) Short head: Common fibular part of sciatic nerve (L5, S1, S2)	Flexes the leg Laterally rotates the flexed leg

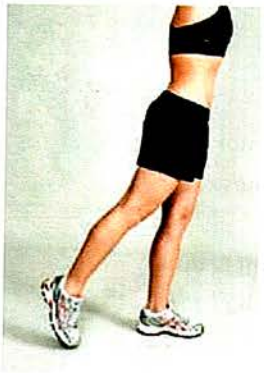
Transverse section of right thigh



→ Any Muscle which pulls the femur Anteriorly crosses the hip joint anteriorly (like ilio Psoas muscle - chief muscle of hip flexion).

→ Any muscle which crosses hip joint posteriorly, kike gluteus maximus, will pulli hip joint posteriorly (For hip extension, assisted by hamstring muscle.)

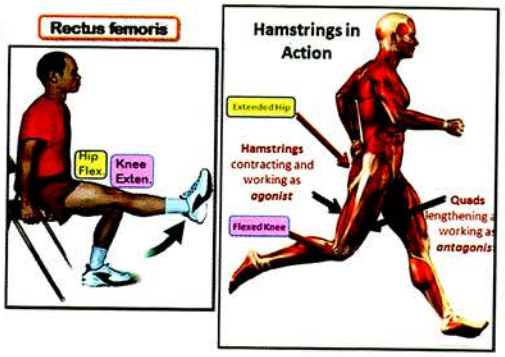
→ Strongest ligament → iliofemoral ligament



Hip extension

Hip flexion

Rectus femoris:

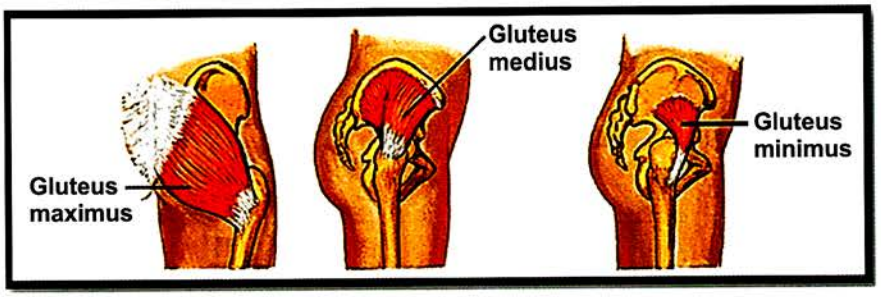


Rectus femoris

First action: at knee (extension)

Second action: at hit (flexion)

Gluteal Region: 3 muscles



1) Gluteus maximus

Proximal attachment

Ilium posterior to posterior gluteal line; dorsal surface of sacrum and coccyx; sacrotuberous ligament

Distal attachment

Most fibers end in iliotibial tract, which inserts into lateral condyle of tibia; some fibers insert on gluteal tuberosity

Innervation-

Inferior gluteal nerve (L5, S1, S2)

Main action

Extends hip joint (especially from flexed position) and assists in its lateral rotation; steadies thigh and assists in rising from sitting position.

2) Gluteus medius

Proximal attachment

External surface of ilium between anterior and posterior gluteal lines

Distal attachment

Lateral surface of greater trochanter of femur

Innervation-

Superior gluteal nerve (L5, S1)

Main action

Abduct and medially rotate hip joint ; keep pelvis level when ipsilateral limb is weight-bearing and advance opposite (unsupported) side during its swing phase.

3) Gluteus minimus

Proximal attachment

External surface of ilium between anterior and inferior gluteal lines

Distal attachment

Anterior surface of greater trochanter of femur

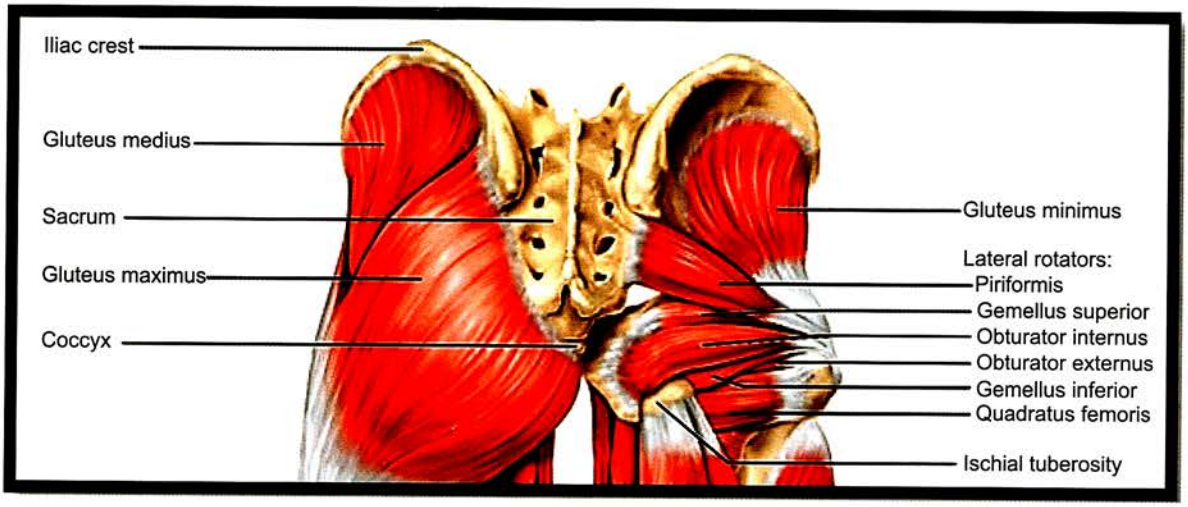
Innervation-

Superior gluteal nerve (L5, S1)

Main action

Abduct and medially rotate hip joint ; keep pelvis level when ipsilateral limb is weight-bearing and advance opposite (unsupported) side during its swing phase.

There are six lateral rotators of the thigh: piriformis, obturator internus, superior and interior gemelli, quadratus femoris, and obturator externus. These muscles also stabilize the hip joint.

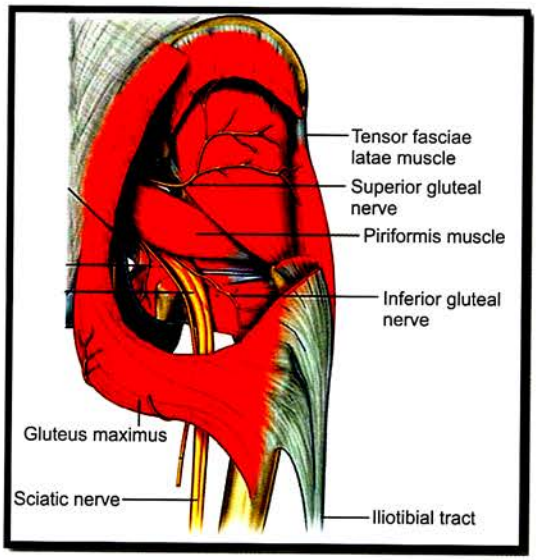


Superior Gluteal nerve supplies

1. *Gluteus medius*
2. *Gluteus minimus*
3. *Tensor facia lata*

Sciatic nerve :

Sciatic nerve supplies back of thigh, the leg and foot region. It passes through the gluteal region, but doesn't supply the area

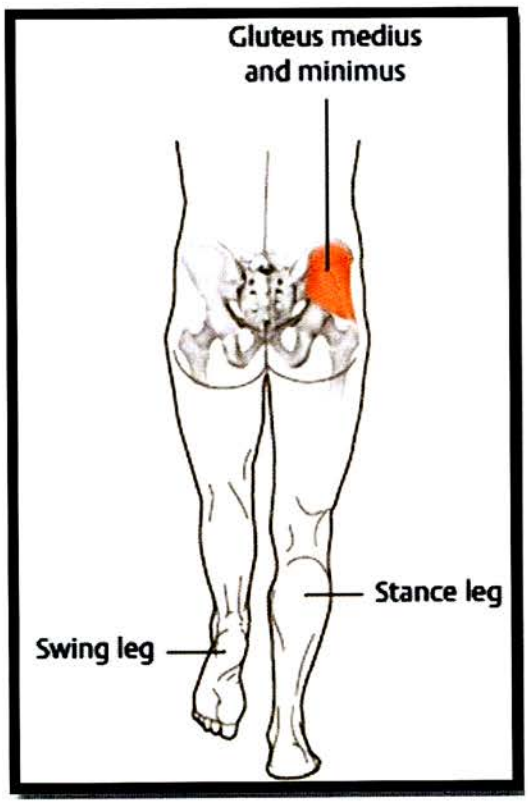


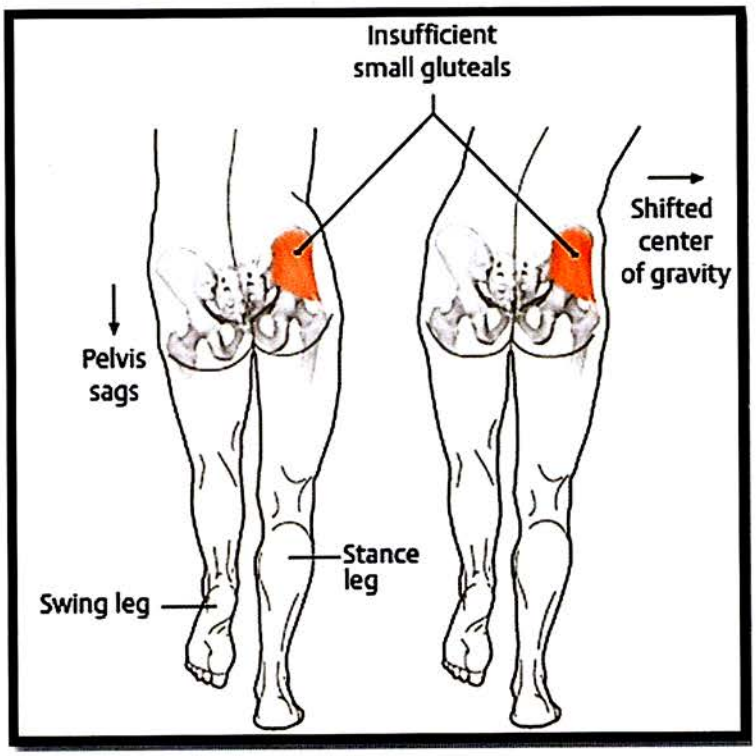
Muscles of the Gluteal Region (Abductors and Rotators of the Thigh)

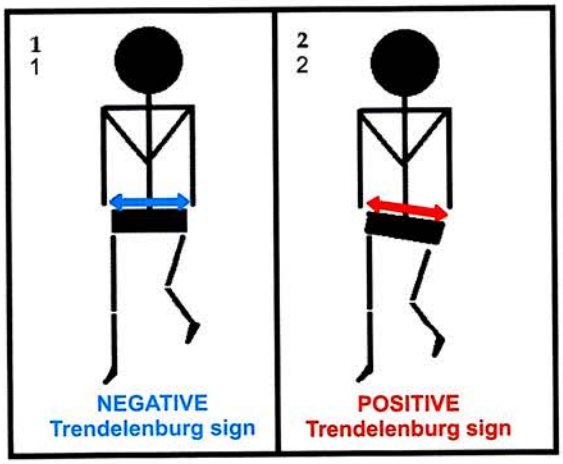
Muscle	Innervation	Action
Gluteus maximus	Inferior gluteal nerve (L5, S1, S2)	Extends the thigh(especially from a flexed position) Assists in lateral rotation of the thigh Assists in rising from a sitting position
Gluteus medius	Superior gluteal nerve (L5, S1)	Abducts and medially rotates the thigh
Gluteus minimus	Superior gluteal nerve (L5, S1)	Abducts and medially rotates the thigh
Tensor of fascia lata	Superior gluteal nerve (L5, S1)	Abducts and medially rotates the thigh
Piriformis	Branches of anterior rami S1, S2	Laterally rotates extended thigh Abducts flexed thigh
Obturator internus	Nerve to obturator internus (L5, S1)	Laterally rotates extended thigh Abducts flexed thigh
Superior gemellus	Nerve to obturator internus (L5, S1)	Laterally rotates extended thigh Abducts flexed thigh
Inferior gemellus	Nerve to quadratus femoris (L5, S1)	Laterally rotates extended thigh Abducts flexed thigh
Quadratus femoris	Nerve to quadratus femoris (L5, S1)	Laterally rotates the thigh

Pelvic rotation: Gluteus medius and gluteus minimus musclesconstitute the major abductors of the hip and are demonstrated by asking the subject to stand on one limb. The ipsilateral muscles contract to stabilize the centre of gravity and maintain a relatively horizontal pelvic position. – During walking, gravity tends to tilt pelvis and trunk to the unsupported side, these muscles prevent this unwanted movement, by counteracting gravity from the opposite side. Paralysis of thee muscles causes pelvic tilt towards the unsupported, contralateral side (**Trendelenburg's sign**). Trendelenburg test is used to assess hip stability.

Positive Trendelenburg sign is seen in the fracture of the femoral neck, hip dislocation (head of femur), or weakness and paralysis of the gluteus medius (abductor).



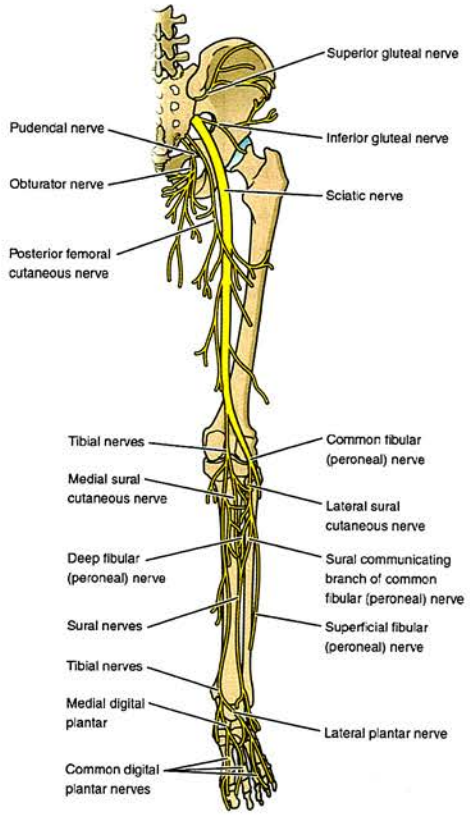




Sciatic nerve

is the thickest nerve in the body
-It arises from sacral plexus
in the pelvis and consists of two parts
-tibial part and common peroneal part.
Tibial part is formed by the ventral divisions
of anterior primary rami of L4, L5; S1, S2, S3.

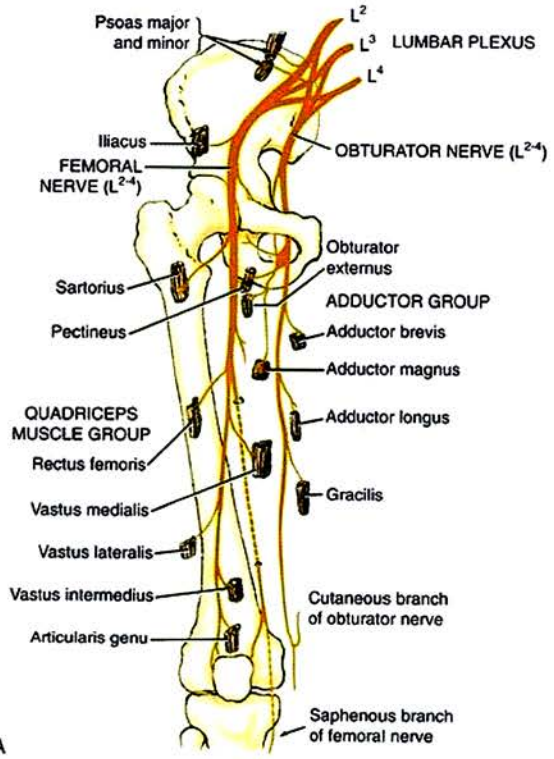
- It enters the gluteal region through the
Greater sciatic foramen below the piriformis.
-It runs downward and slightly laterally under
cover of gluteus maximus midway between the greater
trochanter and the ischial tuberosity, and enters the
back of the thigh at the lower border of the gluteus maximus.
- In its descent along the posterior thigh, it is crossed by the
long head of biceps femoris and divides into the tibial and common
fibular (peroneal) nerves proximal to the knee.



Obturator Nerve (L2–4)

It is the nerve of the medial compartment of the thigh.

It arises from the anterior divisions of the
L-2, 3, 4 ventral rami,
It crosses the sacroiliac joint behind the
common iliac artery and lateral to the
internal iliac vessels, runs along the lateral
pelvic wall medial to obturator internus,
and enters the thigh through the upper
part of the obturator foramen.
Near the foramen, it divides into anterior and posterior
branches, which are separated at first by part of obturator
externus and more distally by adductor brevis.
it provides articular branches to the hip
and knee, and may supply skin on the medial thigh and leg.
Damage to the obturator nerve causes a weakness of adduction
and a lateral swinging of the limb during walking because
of the unopposed abductors.



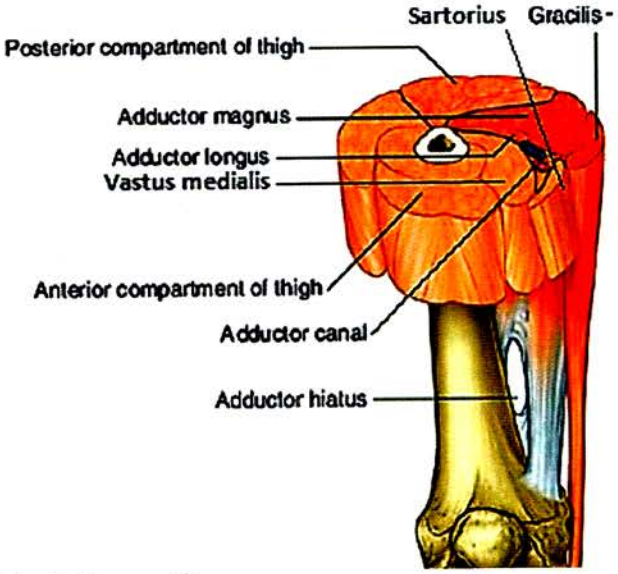
A

Femoral nerve

- → L- 2,3,4
- → Dorsal division
- → Supply the muscle of ant. Thigh (Quadriceps femoris)
- → Nerve of knee extension

Thigh

- → Femoral Δ le seen in upper 1/3 rd of thigh
- → Adductor canal seen in middle 1/3 rd of thigh
- → Popliteal fossa seen in Lower 1/3 rd of thigh

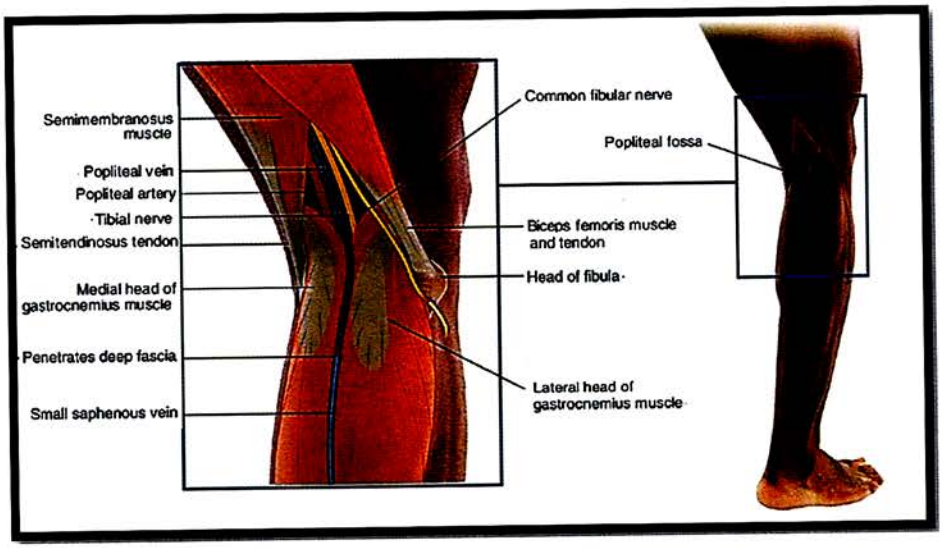


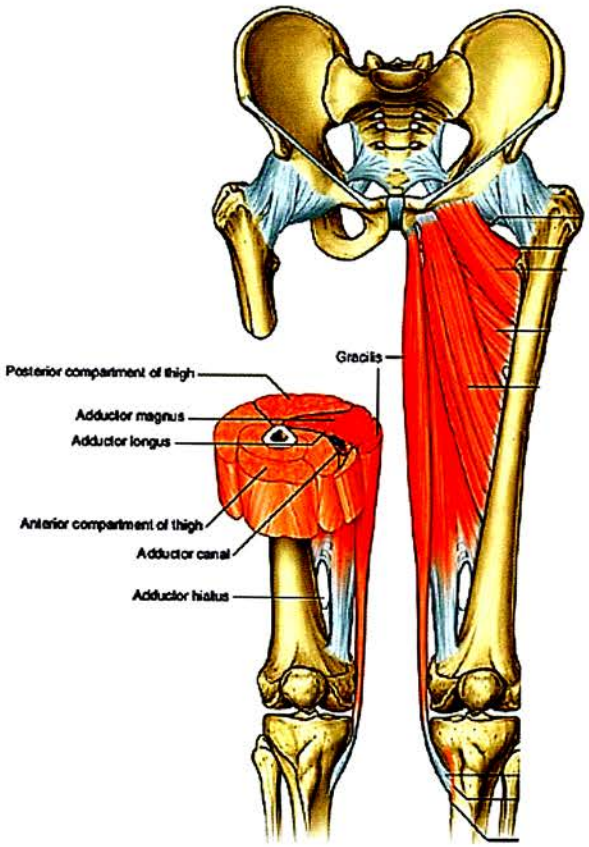
Femoral Triangle - contains

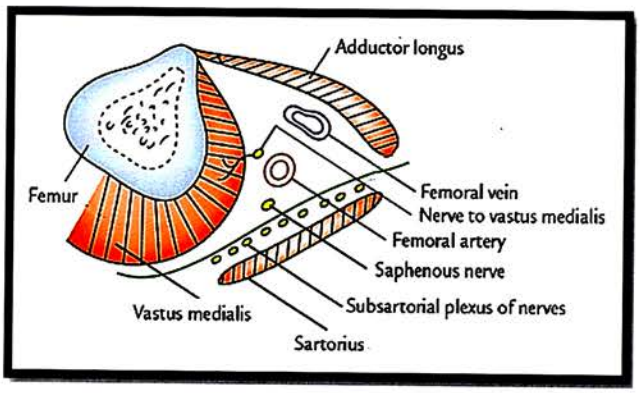
Femoral vein
Femoral Artery } Medial to lateral
Femoral nerve

The saphenous nerve does not leave through the adductor hiatus but penetrates superficially halfway through the adductor canal.

Popliteal fossa is the diamond-shaped space, approximately 2.5 cm wide.
It is bounded superomedially by the semimembranosus and semitendinosus, superolaterally by the biceps femoris, inferomedially by the medial head of the gastrocnemius, and inferolaterally by the lateral head of the gastrocnemius (and plantaris).
Roof: is perforated by the short saphenous vein, posterior cutaneous nerve of thigh and medial and lateral sural cutaneous nerves.
Floor : Has popliteus muscle.
It contains the popliteal vessels, the common peroneal and tibial nerves, and the small saphenous vein.
The common fibular nerve descends laterally immediately medial to the tendon of biceps femoris.
The popliteal artery is crossed superficially by popliteal vein from the lateral to medial side; which in turn is crossed superficially by the tibial nerve from the lateral to medial side.







Triple Triad injury

This is a case of terrible (triple) triad and leads to damage of three ligaments:

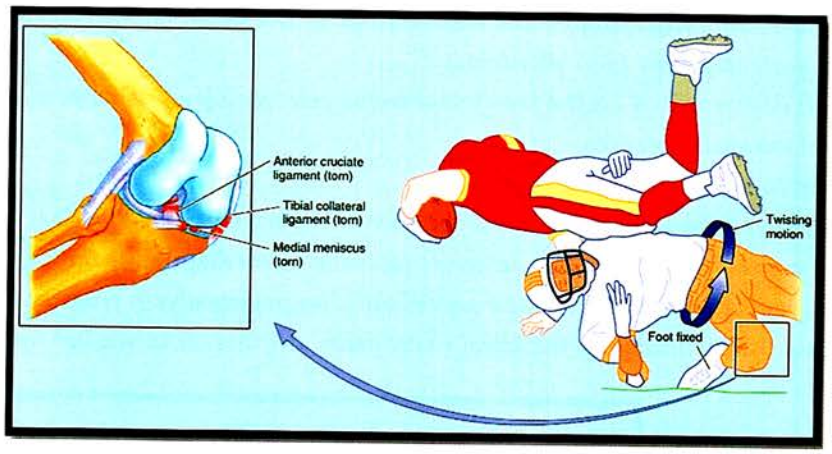
Mechanism of Injury:

Foot fixed, knee flexed, twisting fall.

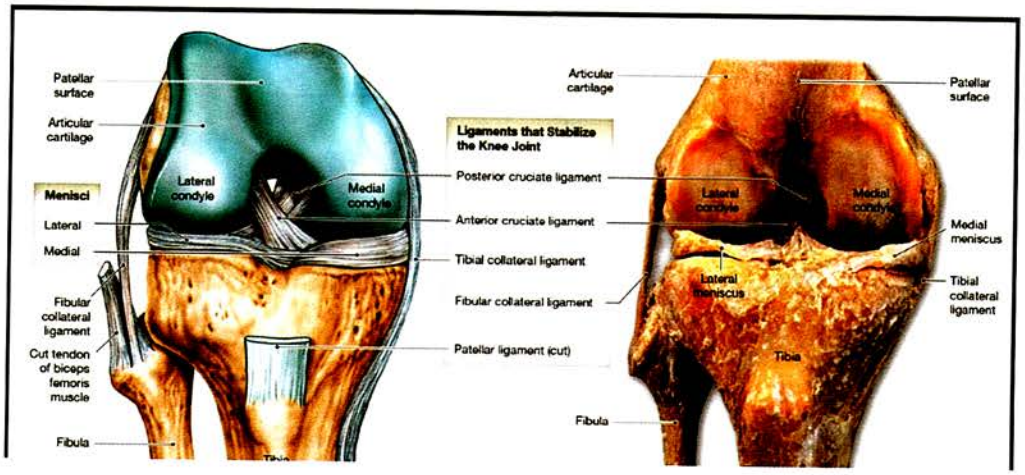
TCL (Tibial Collateral Ligament), medial meniscus

ACL (Anterior Cruciate Ligament).

Lachman test becomes positive.



Knee Joint

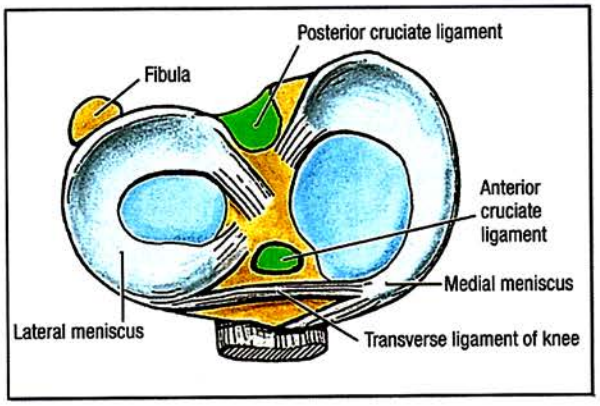


Acl

→ anteriorly attached to tibia in inter condylar region

→ running backward, upward & lateral & attach lateral condyle of femur medially & posteriorly

→ Intra capsular origin



Pcl

→ Comes from posterior aspect of tibia from intercondylar region

→ runs anteriorly & medially & forward

→ attaches to lateral surface of medial condyle

Coronary Ligament of knee joint / Meniscotibial ligament

Lower part of capsule connecting femur & tibia

Fibular / Lateral Collateral Ligament

→ present on lateral side attaching to fibula

→ extra Capsular

Tibial/Medial Collateral Ligament

→ Present on medial side attached to tibia

→ extra capsular

NOTE-Acl prevents posterior displacement of femur on tibia & anterior displacement of tibia & anterior displacement of tibia

Sequence of attachment of ligaments on inter-condylar ridge;

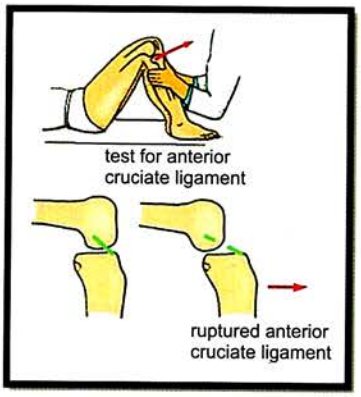
College → Cruciate ligament posterior
Medical → Medial Leminiscus
Lucknow → Lateral meniscus posterior
Lucknow → Lateral meniscus anterior
College → cruciate ligament Anterior
Medical → Medial Ligament

ACL → prevents the posterior displacement of femur & Anterior displacement of tibia

→ Tightened at extension
→ ACL damaged in hyper extension injury
→ Weak ligament than PCL

PCL → prevents the anterior displacement of femur & posterior displacement of tibia
→ tightened at Flexion

Anterior Drawer Test



→ normally, tibia can't be pulled anteriorly
(Prevented by ACL)
→ In ACL injury, it can be done
→ Ask the patient to lie down & do 90° knee flexion
Try to pull tibia, if tibia can be pulled, then test & + ive
→ **Painful test**

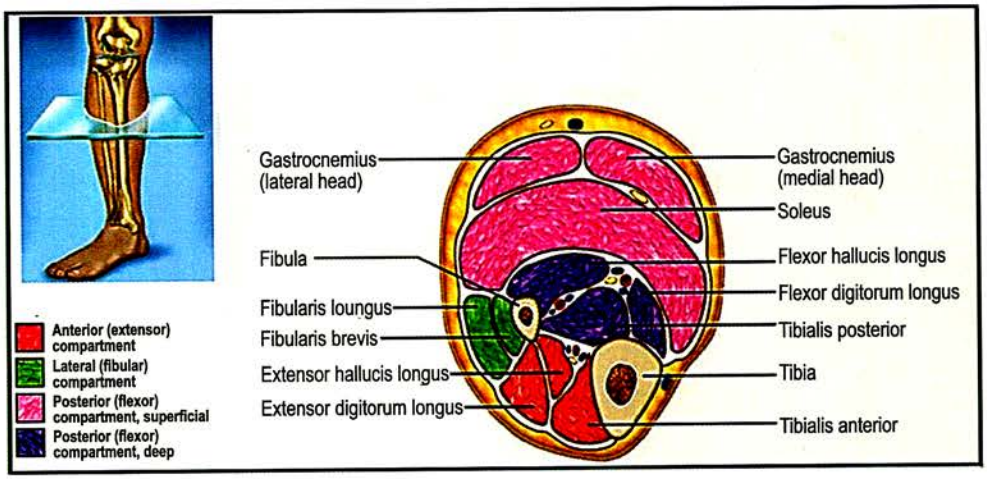
Locking of the knee:

When the foot is fixed on the ground conjunct **medial rotation of the femur** on the tibia in the later stages of extension is part of a 'locking' mechanism, the so-called 'screw-home movement', which is an asset when the fully extended knees are subjected to strain.
Full extension results in the close-packed position, with maximal spiralization and tightening of the ligaments.
Locking of knee joint involves lateral rotation of tibia, if the foot is not fixed to the ground and is free in the air.

Unlocking of the knee

At the beginning of flexion from full extension (with the foot fixed), lateral femoral rotation occurs, which 'unlocks' the join.
The unlocking is carried out by the popliteus.
When the knee is unlocked, it can be further flexed by the hamstring muscles.
Locking of knee is essential for bearing load during erect posture. The locked joint must be unlocked to facilitate progress of locomotion. During walking locking and unlocking of the knee takes place alternatively and rhythmically.

Transverse section of Leg region



Anterior (Extensor) compartment → Causes dorsiflexion of ankle / foot joint

Lateral (Fibular) Compartment → Eversion (turns the sole lateral)

Posterior (Flexor) Compartment →

Superficial Deep → Plantar Flexion

→ Toe Flexion

Posterior Compartment muscles

G → Gastrocnemius
P → Plantaris
} superficial group in call region

S → Sloeus

T → tibialis posterior

D → Digitorum longus (flexor)

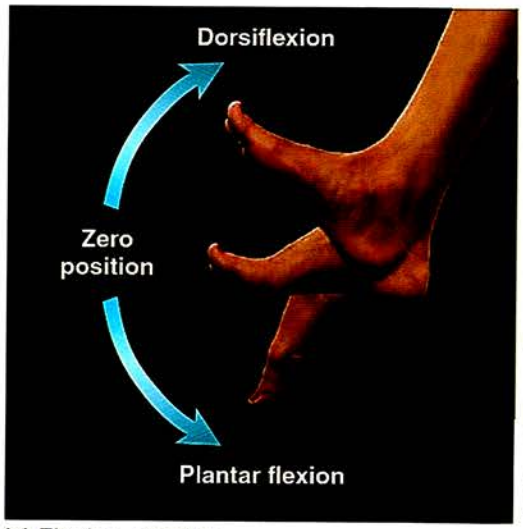
H → Hallucis longus (extensor)

Lateral Compartment muscles

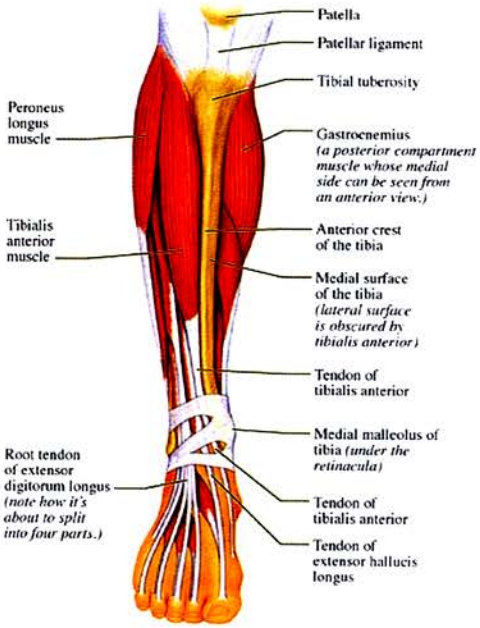
Peroneus longus
Peroneus brevis
} Everters

Muscles of the Anterior Compartment of the Leg

Muscles	Innervation	Action
Anterior Compartment		
Tibialis anterior	Deep fibular nerve (L4, L5)	Dorsiflexes the foot Inverts the foot
Extensor digitorum longus	Deep fibular nerve (L5, S1)	Dorsiflexes the foot Extends lateral four toes
Extensor hallucis longus	Deep fibular nerve (L5, S1)	Dorsiflexes the foot Extends the big toe
Fibularis tertius	Deep fibular nerve (L5, S1)	Dorsiflexes the foot Assists in eversion of the foot

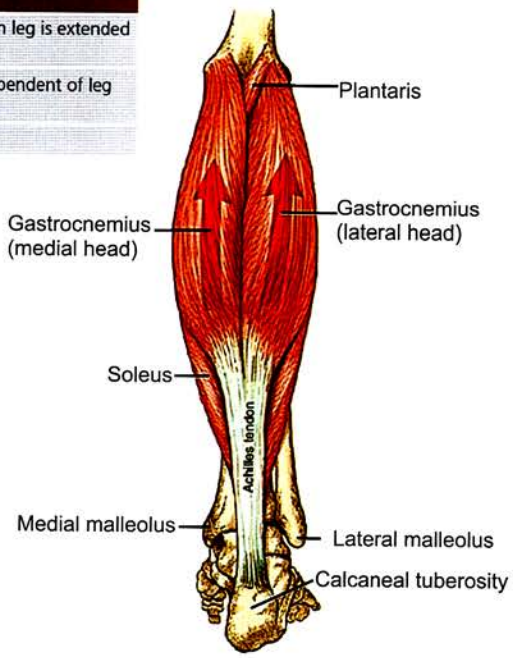


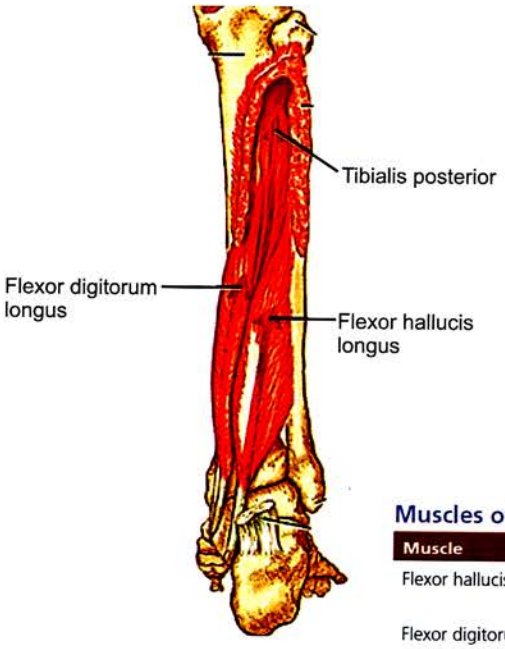
(a) Flexion of ankle



Muscles of the Posterior Compartment of the Leg

Muscle	Innervation	Action
Gastrocnemius	Tibial nerve (S1, S2)	Planter flexes the ankle when leg is extended Flexes the leg
Soleus	Tibial nerve (S1, S2)	Plantar flexes the ankle independent of leg position
Plantaris	Tibial nerve (S1, S2)	Assists the gastrocnemius

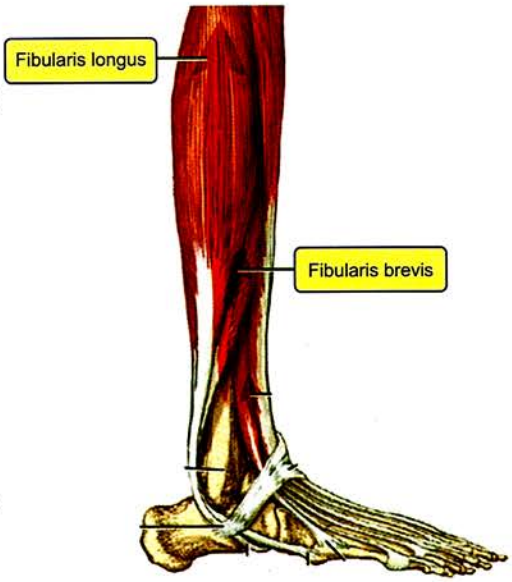




Muscles of the Posterior Compartment of the Leg

Muscle	Innervation	Action
Flexor hallucis longus	Tibial nerve (S2, S3)	Flexes the big toe at all joints Plantar flexes the ankle weakly
Flexor digitorum longus	Tibial nerve (S2, S3)	Flexes the lateral four toes Plantar flexes the ankle
Tibialis posterior	Tibial nerve (L4, L5)	Plantar flexes the ankle Inverts the foot

Lateral Compartment



Eversion

→ Foot eversion occurs at subtalar Joint (Talocalcaneal joints)

→ done by

1.Peroneus Longus

2.Peroneus brevis

3.Peroneus tertius

Inversion

→ done by

Tibialis anterior

Tibialis posterior

Supination → Inversion + fore foot adduction + planter adduction

Pronation → Eversion + Fore foot abduction ++ dorsification

Pronation, Supination occurs at subtalar joint & transverse torsal joint (Fore foot adduction & abduction)

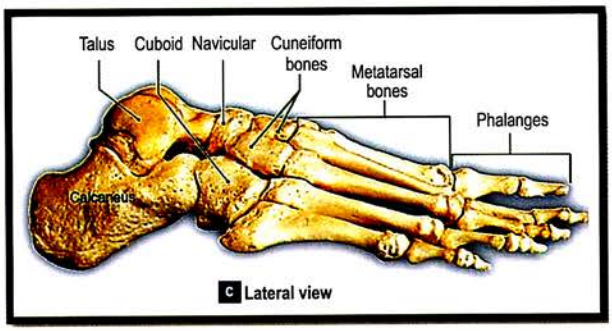
Lateral Compartment muscles maintain Lateral Longitudinal arch (especially peroneus longus)

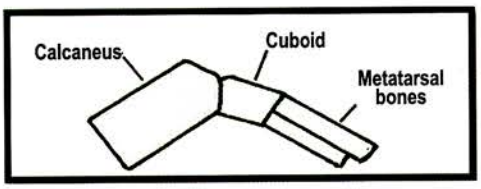
Lateral Longitudinal Arch

→ useful in weight transmission & flexibility

→ Contributed By

1. **Cuboid (Lateral bone)**
2. **Navicular (Medial bone)**
3. **Calcaneus (heel bone)**
4. **Calcaneocuboid Joint (saddle synovial joint)**
5. **Metatarsals 4,5**





Anterior pillar → Metatarsals

Posterior pillar → Calcaneum

Summit → cuboid

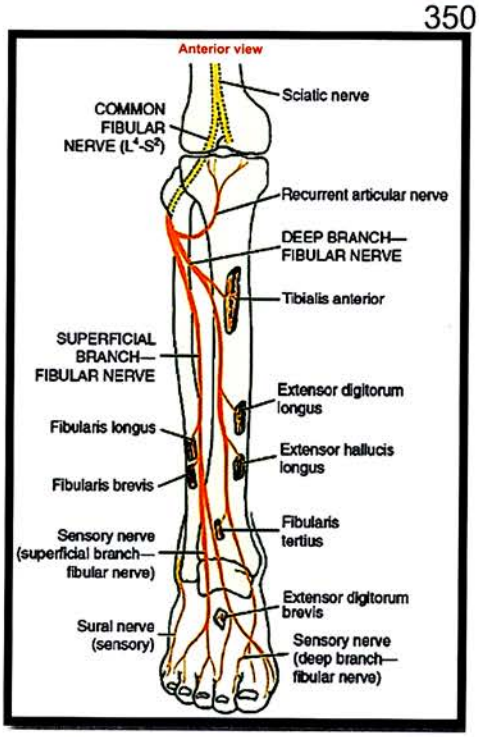
Tendons → Peroneus longus (main)
Peroneus pervis

Ligaments → Short & planter ligament

Eversion

Inversion

Leg & Foot Region: Nerve Supply



Common Peroneal Nerve

→ Sciatic nerve gives common peroneal nerve behind the knee joint near popliteal fossa
→ Present under cover of biceps femoris in the superolateral boundary of popliteal fossa, & winds around lateral neck of fibula & gives deep & superficial branches.
→ If damaged, foot drop occur
→ Loss of dorsiflexion
→ d/t injury to deep peroneal nerve

Superficial Peroneal Nerve

→ Going lateral & Supplies
Peroneus longus
Peroneus brevis
→ Nerve of eversion
→ Also supplies most of skin on dorsum of foot (skin on dorsum of 1st web space supplies by

Deep peroneal nerve / Anterior Tibial Nerve (L5)

→ Comes anterior to tibia
→ Supplies skin or Dorsum of 1st web space

Tibials anterior
Entensor digitorum longus
Extensor hallucis longus
} Dorsi flexion (damage → foot drop)

Tibial Nerve (nerve of flexion)
→ Branch of sciatic nerve
→ Supplies popliteus
→ goes post. to tibia in calf region → Post. Tibial N
→ Post. Tibial Nerve (S1) Supplies

- G → **Gastrocnemius**
- P → **Plantaris**
- S → **Soleus**
- T → **Tibialis posterior**
- D → **flexor Digitorum longus**
- H → **Flexor hallucis longus**

→ Then goes under flexor retinaculum to the medial side of ankle & Supplies little toe & lateral margin or dorsum of foot

Common Peroneal Nerve injury

(Lateral to neck fibula)

Loss of foot eversion

Sensory loss of dorsum of foot

Foot drop

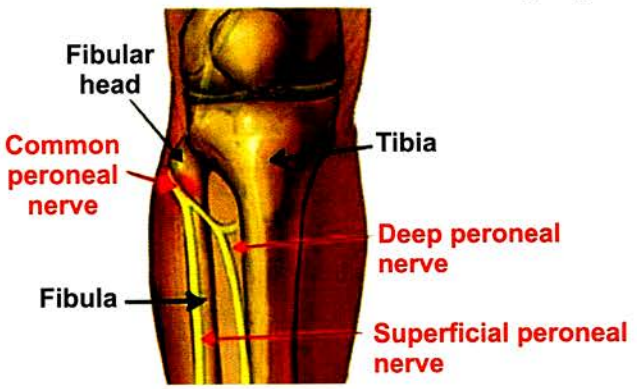
→ d/t tight POP cast below the knee

→ Common peroneal nerve injures

→ Foot drop → loss of dorsiflexion & extension at right ankle joint

→ loss of eversion

→ Sensory loss of dorsum of foot



Cutaneous nerves supplying the lower limb

are derived from the branches of nerves of lumbar and sacral plexuses.

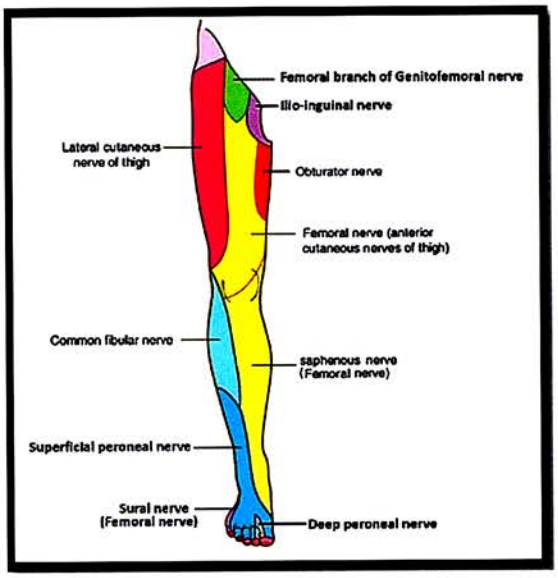
Most of the cutaneous innervation of the thigh is provided by the **lateral and posterior cutaneous nerves** of the thigh and cutaneous branches of the femoral nerve.

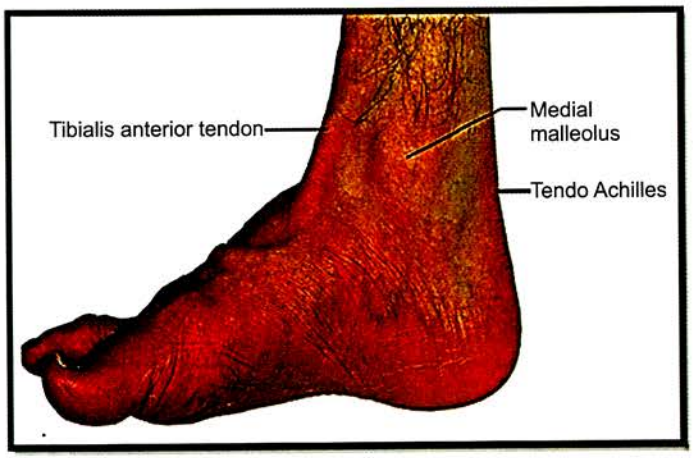
Anterior cutaneous nerves from the femoral nerve in addition to the anterior aspect of the thigh also supply the most of the medial aspect of the thigh.

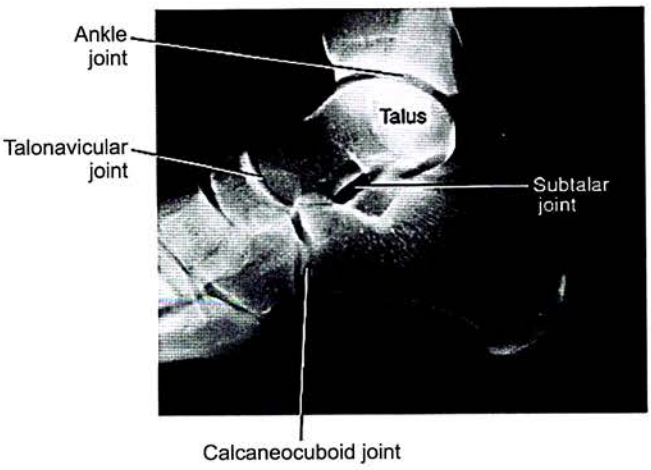
Cutaneous innervation of the leg on its anteromedial aspect is provided by the saphenous nerve, the posterolateral aspect by the sural nerve, and the anterolateral aspect by the superficial peroneal nerve.

Cutaneous innervation of dorsum of the foot is mostly provided by the superficial peroneal nerves.

Cutaneous innervation of the sole of the foot is provided by the cutaneous branches of the medial and lateral plantar nerves.







Deltoid ligament: 4 parts

1. Anterior tibiotalar
2. Posterior tibiotalar
3. Tibiocalcaneal part
4. Tibionavicular part

Note-spring ligament not a part of deltoid ligament

Sub Talar joint / Talo Calcanial joint

→ helps in eversion, inversion

2 inverters → tibialis anterior
→ tibialis posterior

2 evertors → Peroneus longus
→Peroneus brevis

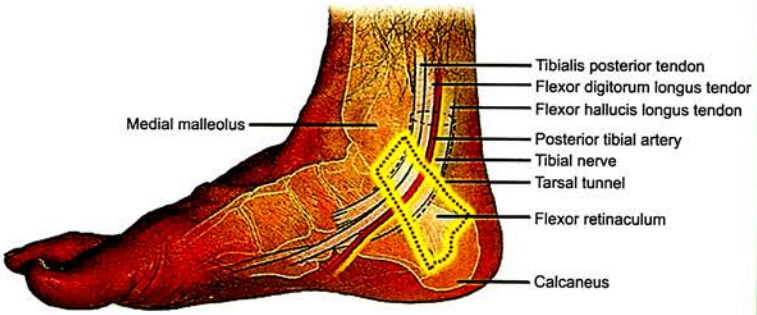
Medial Bone forming Medial longitudinal arch → Navicular

Talocalcaneal Navicular joint → ball & Socket joint

Ball → head of Talus

Socket → Calcaneus navicular
→ Helps in Supination & pronation

Flexor Retinaculum

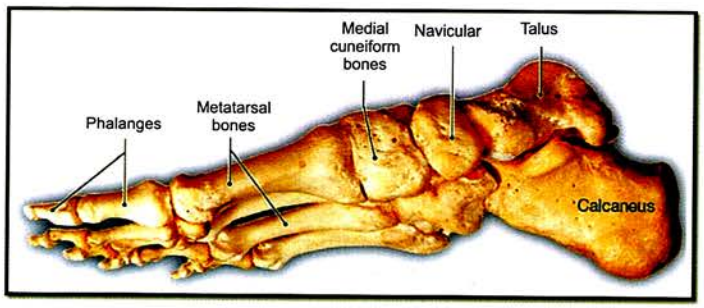


Flexor retinaculum is attached anteriorly to the medial malleolus, then extends posteroinferiorly to attach to the medialprocess of the calcaneus (and the plantar aponeurosis). It forms the **tarsal tunnel** and holds three tendons and blood vessels and a nerve in place deep to it (in anteromedial to posterolateral direction): Tibialis posterior, flexor Digitorum longus, posterior tibial Artery (and vein), tibial Nerve, and flexor Hallucis longus (Mnemonic: **Tom, Dick ANd Harry**).

Tarsal tunnel syndrome is a complex symptom resulting from compression of the **tibial nerve** or its medial and lateral plantar branches in the tarsal tunnel, with pain, numbness, and tingling sensations on the ankle, heel, and sole of the foot.

Symptoms can be relieved by surgical division of the retinaculum.

Medial longitudinal arch is formed by



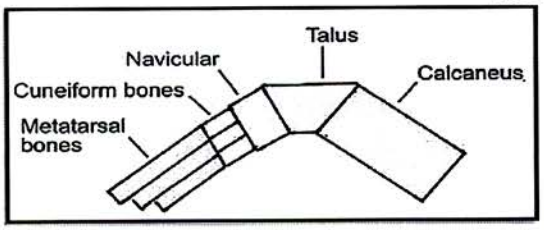
Talus, calcaneus, navicular, cuneiform, and three medial metatarsal bones.

→ Helps in running jumping

The head of the talus, which is located at the summit between the sustentaculum tali and the navicular bone. It is supported by the **spring ligament** and the tendon of the flexor hallucis longus.

Flat foot (pes planus or talipes planus) is a condition

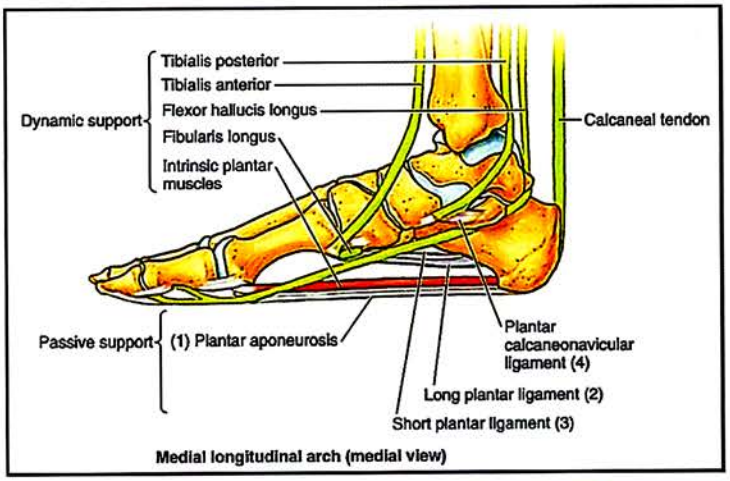
of disappearance or collapse of the medial longitudinal arch with eversion and abduction of the forefoot and leads to pain as a result of stretching of the plantar muscles and straining of the spring ligament and the long and short plantar ligaments.



→ **Passive Supporters**
Plantar aponeurosis
Pulls ant. Pillor close to post. Pillar to maintain the arch

Spring Ligament
Support head of talus

→ **Dynamic Supporters**
Flexor Hallucis longus
Tibialis anterior

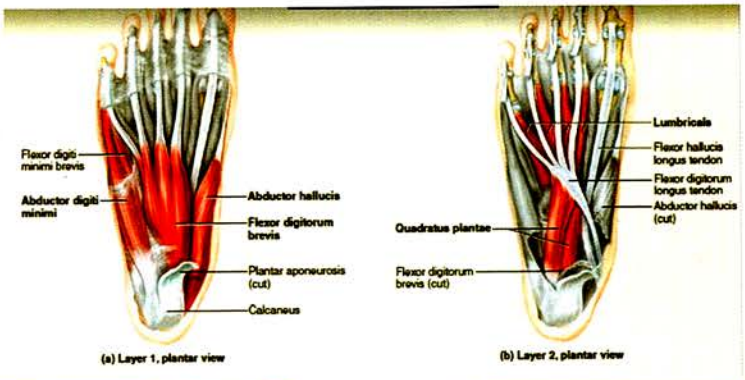


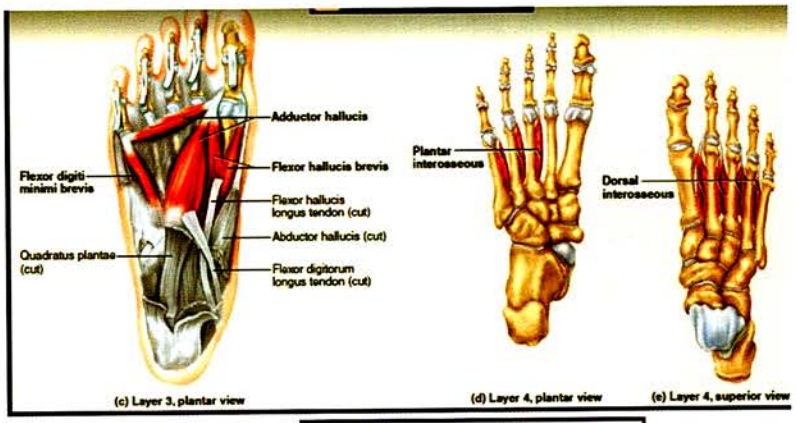
Sole Muscles

1st Layer → Abductor Hallucis
2nd Layer → Lumbricals (comes from flexor digitorum longus)
3rd Layer → Adductor Hallucis
4th Layer → Interossei

Lumbricals → Flex proximal phalanges of lateral four toes Extend middle and distal phalanges of lateral four toes

If Lumbricals & Interossei are paralysed → Claw foot Deformity

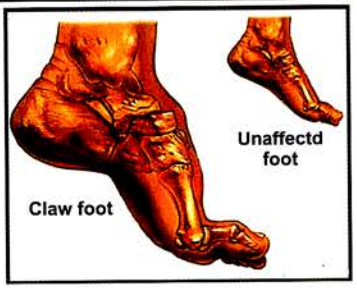




Abductor hallucis →
Abducts and flexes the big toe
Adductor hallucis →
Adducts the big toe

Arterial Supply

→ External iliac artery pass under inguinal ligament to continue as Femoral Artery
→ Femoral Artery gives profunda Femora Artery (Deep artery of thigh)

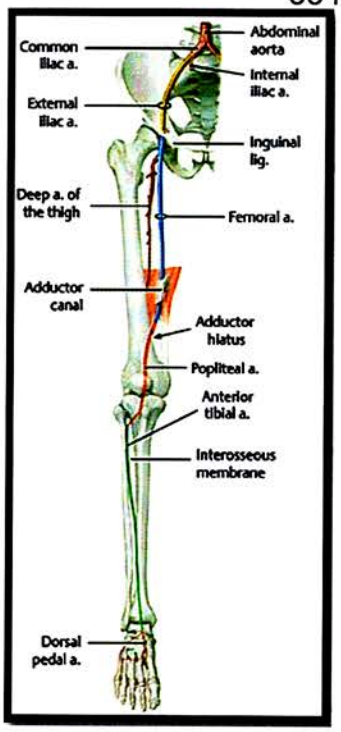


Arterial supply

Femoral Artery

→ Present in adductor canal in middle 1/3rd of thigh

→ Passes adductor hiatus & enters popliteal fossa as popliteal artery behind the knee joint.



Popliteal artery gives

1) Anterior Tibial Artery (runs anteriorly to tibia)

Continues to dorsum of foot as Dorsalis Pedis Artery

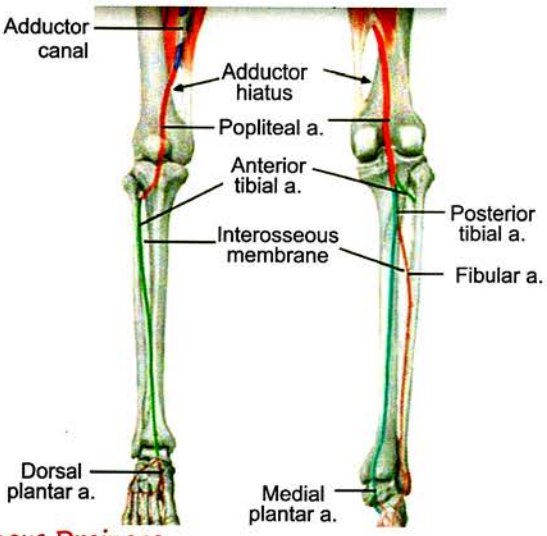
2) Tibio Peroneal Trunk : goes into sole and divides into:

1. **Posterior tibial (posterior to tibia)**–Pass under flexor retinaculum on medial side of ankle & divides into medial & lateral plantar arteries & supplies sole
2. **Fibular artery** (do not go to lateral compartment) but supplies muscles of lateral compartment

→ Anterior division of Internal Iliac artery gives obturator artery to medial thigh which passes obturator foramen in hip bone

→ **chief artery in thigh → Profunda Femoral Artery**

- Supplies posterior, anterior & medial thigh
- Gives Ant. & post circumflex femoral arterioes & supplies head of femur
- Major artery for the head or demur → Retinocular A br. Of middle circumflex femoral artery (Intracapsular # neck of femur causes Avascular necrosis)



Venous Drainage

Superficial Group (sub cutaneous)

→ Great Saphenous vein

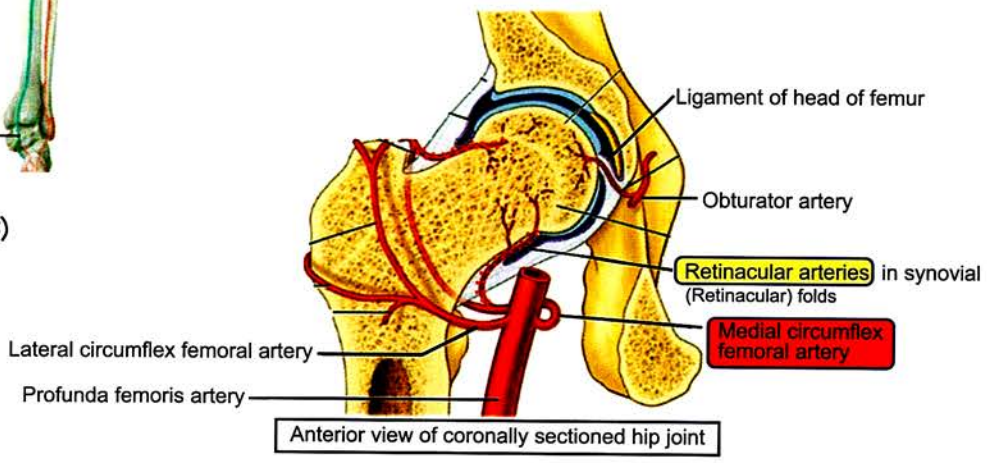
short saphenous vein etc

Deep Group

→ popliteal vein

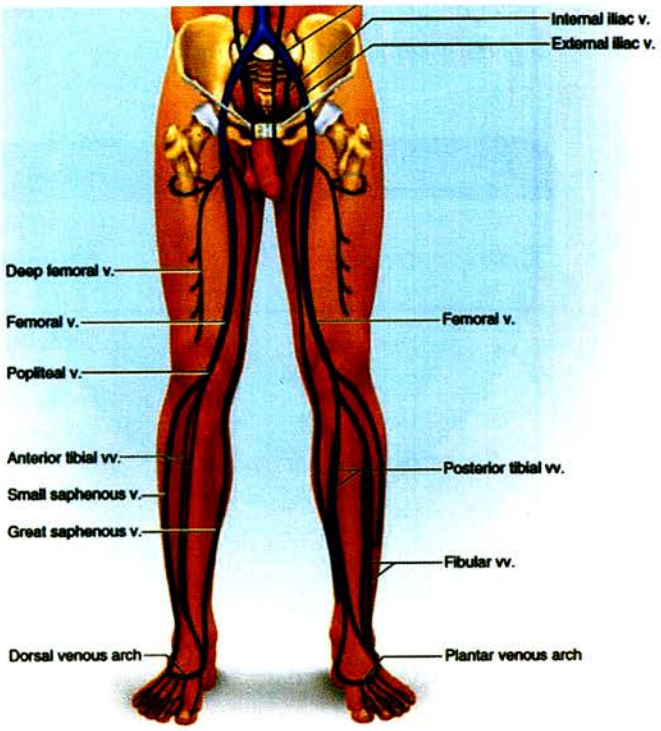
Femoral Vein

Tibial vein etc



Anterior view of coronally sectioned hip joint

→ Deeper veins collect blood from superficial veins
→ Perforators prevents blood coming back into superficial veins from deep veins
→ incompetent perforators leads to varicosity
→ Dorsal Venous arch gives Greater Saphenous Vein
→ GSV passing anterior to medial malleolus (site for Venesection in burn pt.) ascend up in leg & thigh region & drains into femoral veins
→ Femoral vein is the continuation of popliteal vein in popliteal fossa
→ Popliteal vein formed by the union of tibial vein (deeper veins)
→ Great saphenous are saphenous are superficial vein
→ Profunda Femoral vein drains into femoral vein
→ Femoral vein after passing into under inguinal ligament, becomes Ext. Iliac vein & receives int. Iliac join to form common iliac vein
→ Common iliac Veins on both sides contribute to IVC

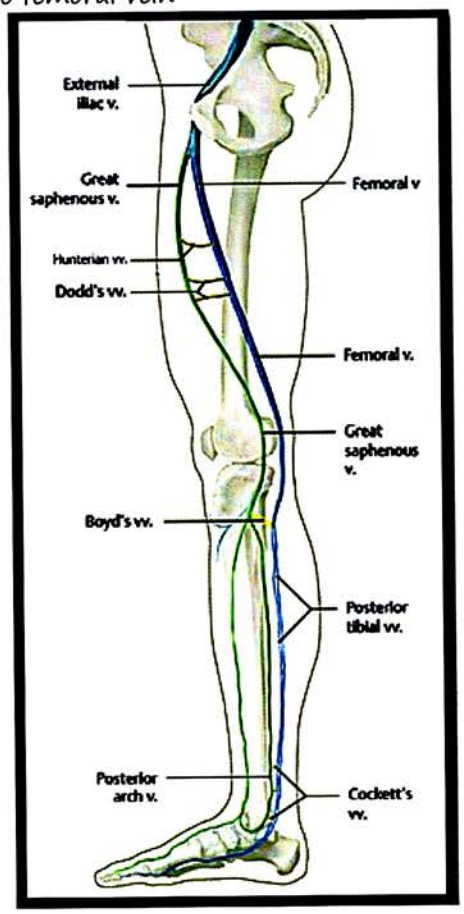


Great Saphenous Vein

→ Comes from dorsal venous arch, passes anterior to medial malleolus & goes up slightly behind & again comes anterior & enters into cribriform fascia to enter femoral vein
→ in varicose surgery, it is ligated & removed as close as possible to femoral vein

Short Saphenous vein

→ runs Lateral to archilis tendon, runs posterior in leg region, drains into popliteal vein piercing the roof of popliteal fossa



Perforators

Supra Ankle Cockett's Perforators

→ drains the superficial blood into deeper veins
→ Superficial vein → Posterior Arch vein
Deeper vein → Posterior tibial vein

Dodd's Perforator

→ Present above the knee
→ b/w femoral vein & great saphenous vein

Boyd's Perforator

→ Present below the knee
→ b/w great saphenous vein & post tibial/popliteal vein
→ Present on medial side of ankle
→ attaching to medial side of lower end of tibia & Calcaneum

→ Posterior tibial nerve passing under flexor retinaculum
& gives medial, Lateral plantar nerve

Table 34.10 [illegible] of the leg

Compartment		Muscular contents	Neurovascular contents
① Anterior compartment		Tibialis anterior	Deep fibular n. Anterior tibial a. and v.
		Extensor digitorum longus	
		Extensor hallucis longus	
		Fibularis tertius	
② Lateral compartment		Fibularis longus	Superficial fibular n.
		Fibularis brevis	
Posterior compartment	③ Superficial part	Triceps surae (gastrocnemius and soleus)	—
		Plantaris	
	④ Deep part	Tibialis posterior	Tibial n. Posterior tibial a. and v. Fibular a. and v.
		Flexor digitorum longus	
		Flexor hallucis longus	

Abdomen 1

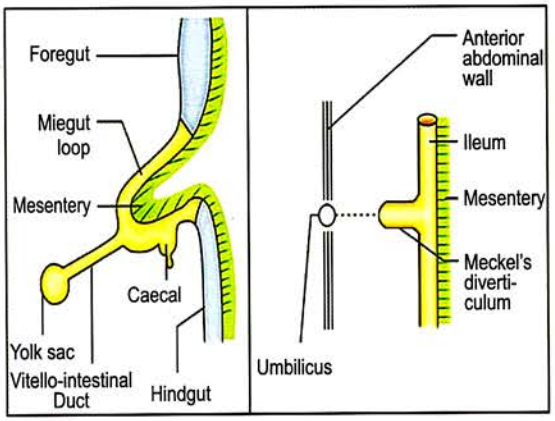
Gametogenesis

Alimentary Canal

→ Yolk sac gives 3 parts of the tube: Foregut
Midgut
Hindgut

→ Vitello intestinal duct (VID) connects the midgut to Ant' Abdominal wall.

→ If VID not obliterated – "**Meckel's Anomalies**"



→ Meckel's anomalies brings the faecal matter from terminal ileum to the umbilicus via VID.

→ These anomalies are present at anti-mesenteric border (have all the 4 layers) so called as "**True Diverticulum**"

→ Patients presents with Referred pain at umbilicus (T_{10} dermatome)

Structures	Foregut	Midgut	Hindgut
Organs	Esophagus, stomach, liver, gall bladder, pancreas, ½ of duodenum	½ of duodenum, jejunum, ileum, caecum, ascending colon, 2/3 of transverse colon	1/3 of transverse colon, descending and sigmoid colon, rectum, and 2/3 of anal canal
Arteries and branches	**Celiac** Splenic, left gastric, short gastric, common hepatic, right gastric, gastroduodenal	**Superior Mesenteric** Inferior pancreatico duodenal, intestinal middle colic, right colic, ileocolic	**Inferior Mesenteric** Left colic, superior rectal
Veins	Portal vein	Portal vein	Portal vein
Lymph	Celiac nodes (supracolic compartment)	Superior mesenteric nodes (Infracolic compartment)	Inferior mesenteric nodes (Infracolic compartment)
Nerves: Parasympathetic	Vagus	Vagus	Pelvic Splanchnic, (S2-S4)
Sympathetic	Greater thoracic Splanchnic (T5-T9)	Lesser thoracic Splanchnic (T10,T11,)	Least thoracic Splanchnic (T12)
Pain refers to:	**Epigastric region**	**Umbilical region**	**Suprapubic region**

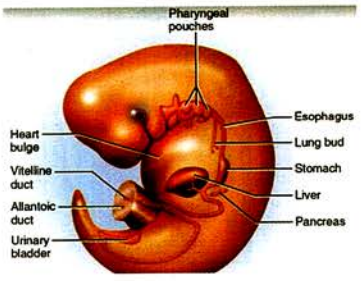
Fistula

→ Along with VID, Allantoic duct is also present as a content of umbilical cord.

→ Obliteration of Allantoic duct → known as "URACHUS"

→ If VID not obliterated → Faecal matter present at umbilicus known as "**Meckel's fistula**"

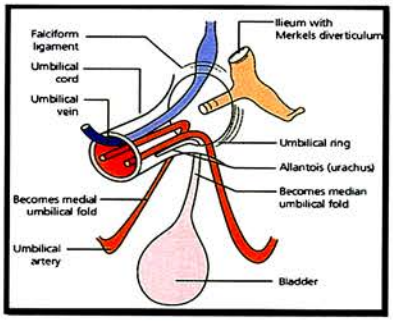
→ If Allantoic duct not obliterated – Urine present at umbilicus



in a newborn known as "**Urachal fistula**".
(passing from apex of urinary bladder)
Other contents of umbilical cord are:

a) 2 umblical Arteries
(Obliterated to form medial umbilical ligament & Covered by median umbilical fold)

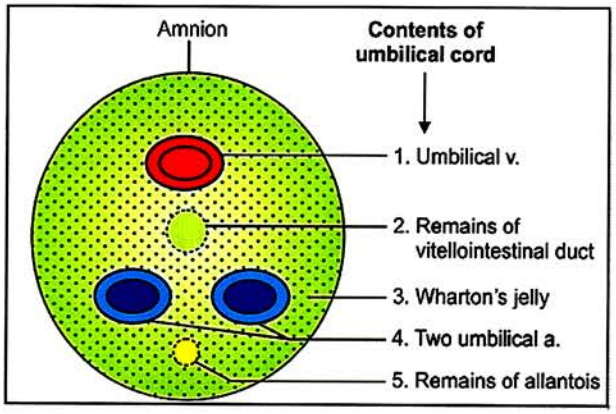
b) 1 umblical vein (Left umbilical vein)
→ Later gets converted into 'ligamentum teres', carried by falciform ligament of Heibert (Towards liver)



Contents Of Umbilical Cord (Covered By Amnion)

1. Wharton's Jelly
2. Remnant of vitello – Intestinal duct
3. Remnant of Allantois
4. 2 Umbilical arteries
5. 1 Umbilical vein (left umbilical vein)

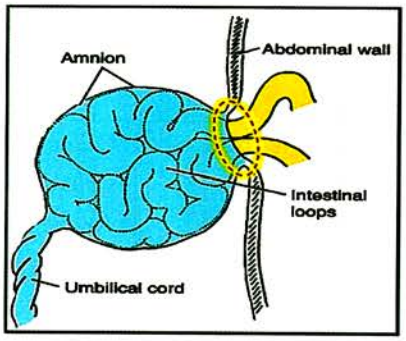
Note → Right Umbilical vein regresses normally



Gastroschisis → If intestine herniates at the site of regression of Right umbilical vein (weak spot), not covered by amnion, is known as Gastroschisis

Omphalocele

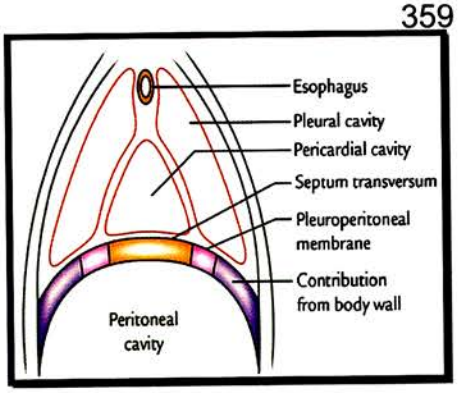
→ Physiological umbilical hernia
→ Part of midgut herniates into umblical cord (temporarily)
→ It physiologically herniates and regresses back later.
→ Non-Regression of omphalocoele is pathological.
→ It is covered by amnion.

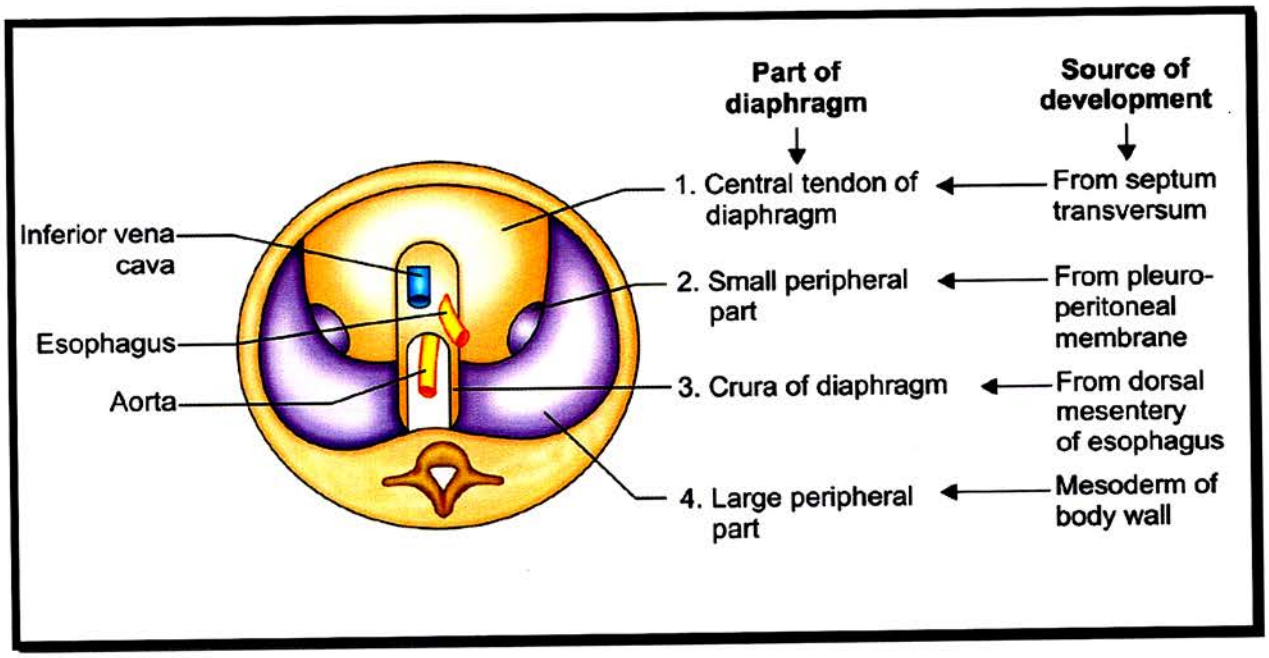


GASTROSCHISIS	OMPHALOCELE
- Right sided - Intestine herniates at weak spot where Right umbilical vein regresses - Umbilical cord is normal - Not lined by Amnion - Recurrent intestinal obstruction is the complication after Rx due to long mesenteric volvulus	Midline defect Umbilical cord contain intestine & liver Lined by Amnion Born dead babies Multiple congenital anomalies (i.e Chromosomal defect, CNS/CVS defects

Development of Diaphragm

1. Septum transversum – form central tendon of diaphragm (also known as Pericardial – Peritoneal membrane)
2. Right & Left Pleuroperitoneal membrane
3. Contribution from body wall.
4. Dorsal mesentry of oesophagus.





Defect in Pleuroperitoneal membrane → Bochdalek Hernia

Bochdalek Hernia

→ Congenital diaphragmatic Hernia
→ Defect in Pleuroperitoneal membrane
→ Most common type of diaphragmatic hernia
→ Some part of intestine & stomach move into the thoracic cavity on left side

↓

* Left lung Hypoplasia
* Right mediastinal shift of Heart
* Compression of Right lung

↓

Difficulty in Breathing, oxygenation

↓

Cyanosis of the newborn after Birth

↓

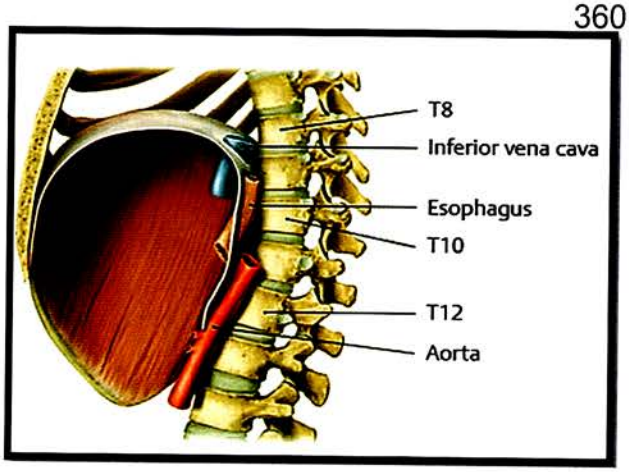
Thus, it's a Neonatal Emergency

3 Major Openings In The Diaphragm

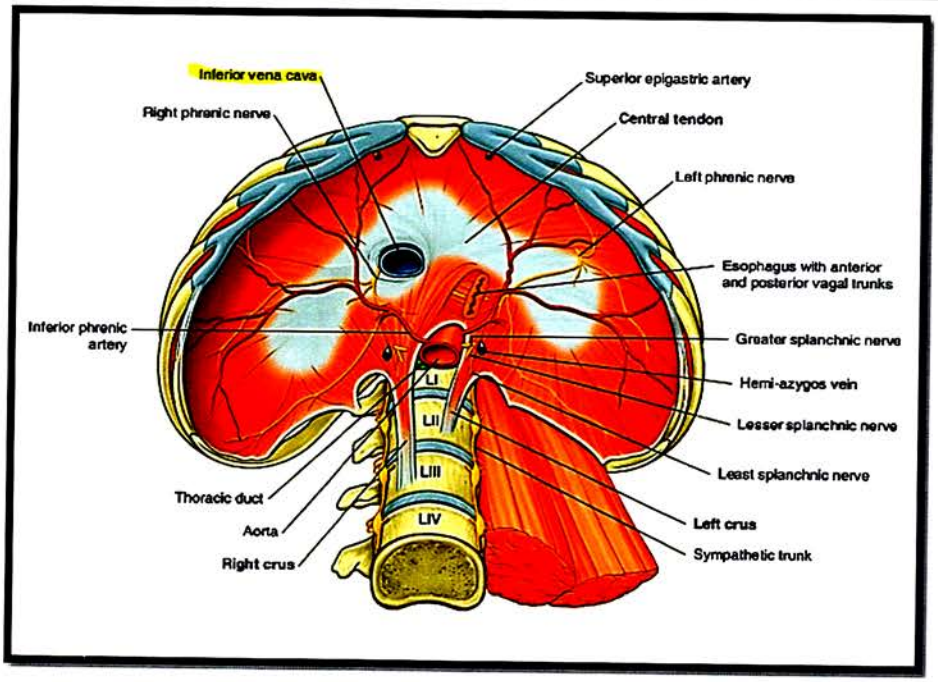
→ Inferior Vena cava → at T_8 level

→ Esophagus → at T_{10} level

→ Aorta → at T_{12} level



Contents via Hiatal Openings



→ Inferior vena cava, Right phrenic Nerve – Caval opening in Central Tendon of diaphragm.

→ Esophagus with Anterior & Posterior Vagal Trunks – Right crus of diaphragm

→ Aorta & Thoracic duct – Aortic Hiatus

Note

→Right crus (L1, L2, L3) of diaphragm is longer than the left crus (L1, L2). Both the crus are connected to each other by Median Arcuate Ligament, which forms an opening known as Aortic Hiatus & allows Aorta to pass through it (also the thoracic duct).

Azygous vein

→ Puncture right crus of diaphragm to enter into the thorax.

→ In some cases, it passes through Aortic hiatus.

Mesentry

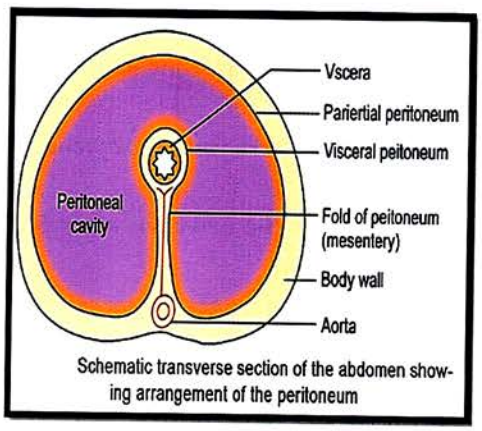
→ Double fold of peritoneum

→ Carries Neurovascular bundle

→ Gut tube is suspended in the peritoneal cavity by Peritoneum

Parietal Peritoneum → Covering the abdominal wall inside

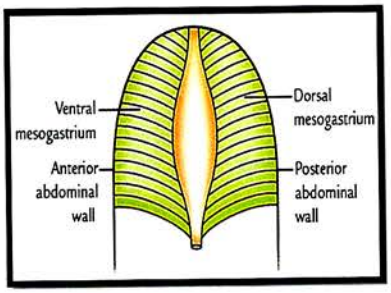
Visceral Peritoneum → Covering the viscera



Schematic transverse section of the abdomen showing arrangement of the peritoneum

Peritoneal Cavity → Between the above 2 layers
Dorsal Mesentry → Present behind the gut tube
Ventral Mesentry → Present infront of gut tube

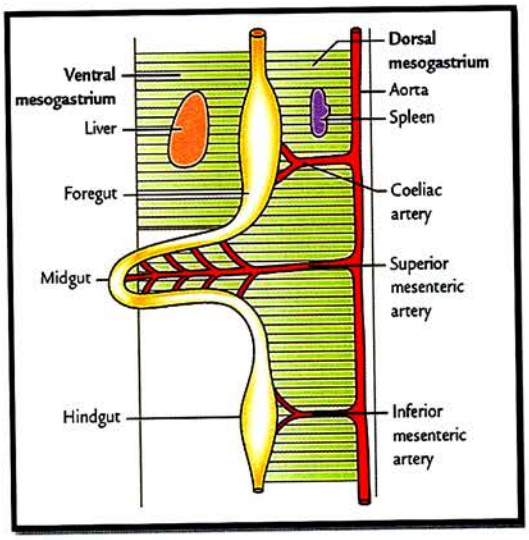
Examples
→ Mesoesophagus
→ Mesogastrium
→ Mesoduodenum



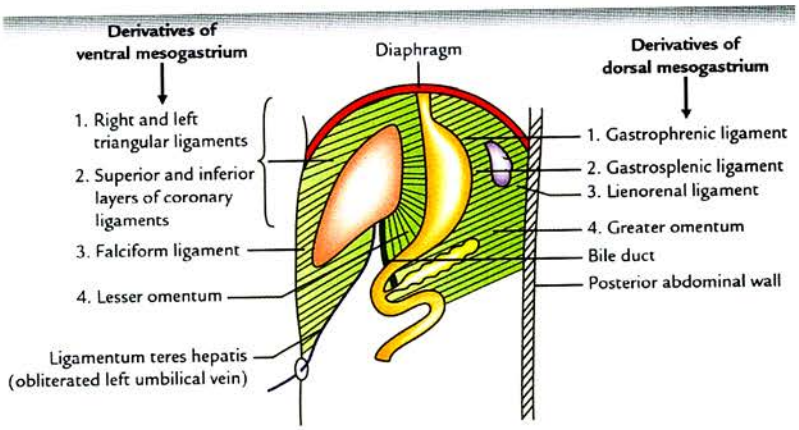
Note
→ Liver & its ligaments develops in ventral mesentry.
→ Spleen & its ligaments develops in dorsal mesentry.

Abdominal Aorta & Its Branches
Foregut → **Celiac Artery**
Midgut → **Superior Mesenteric Artery**
Hindgut → **Inferior Mesenteric Artery**

Superior mesenteric artery goes outside the umbilicus to supply the umbilical cord and the midgut known as **Physiological Umbilical Hernia** at 6 weeks.
(Regresses by 10th week)
↓
Its persistence is known as **Omphalocoele**



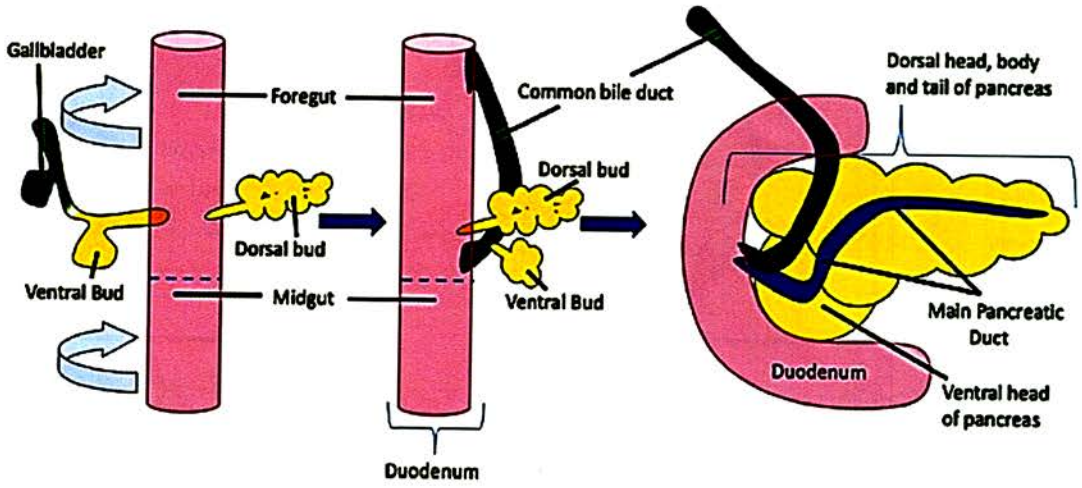
Liver Attachments
Falciform ligament (Anterior & superior)
↓
Coronary ligament (More superior)
↓
Lesser omentum (Posterior)



Lesser Omentum has 2 parts:
a. **Hepatogastric Ligament** → Attaches porta hepatis of liver to lesser curvature of stomach
b. **Hepatoduodenal Ligament** → Attaches porta hepatis of liver to 1st part of duodenum

Porta Hepatis
→ Bile duct (D)
→ Hepatic artery (A)
→ Portal vein (V)

Development of Pancreas



→ Pancreas develops in both ventral (head) & dorsal (body, tail) mesentry
→ Ventral mesenteric bud → in ventral mesentry
Dorsal mesenteric bud → in dorsal mesentry
→ Uncinate process → develops from ventral mesenteric bud, later goes dorsally to fuse with body & tail of pancreas along with the head of pancreas (which develops in dorsal pancreatic bud)
→ Small pancreatic duct → from ventral pancreatic bud
long pancreatic duct → from dorsal pancreatic bud
Thus, **Duct Of Wirsung** → Proximal part – by ventral pancreatic bud
→ Distal part – by dorsal pancreatic bud

Kidney

→ Develops in pelvis, later ascends to abdomen to reach behind spleen.
→ Attached anteriorly to spleen – by leinorenal ligament (developed in dorsal mesentry)

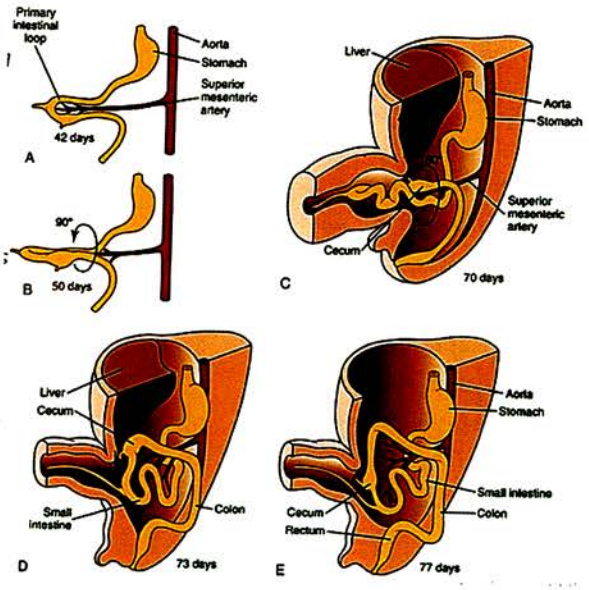
Note

→ Spleen dorsally attached to kidney – by leinorenal ligament
→ Spleen ventrally attached to stomach – by splenogastric ligament

Gut Rotation

- Physiological umbilical hernia at 6 weeks IUL
- Regression of Hernia occurs at week 10 physiologically

→ Superior mesenteric artery going outside the umbilical opening to enter umbilical cord temporarily.
→ Inside the umbilical cord, they start rotating anticlockwise (90 degree)
(Axis of rotation = Sup^{r} mesenteric artery)
→ Rest 180 degree of anticlockwise rotation occurs during regression
→ So, Total 270 degree anticlockwise Rotation occurs
→ After 270 degree rotation,
Duodenojejunal junction – comes to Rt. Side
Ileocaecal junction – comes to left side.
↓ After differential growth
Ileocaecal junction comes to right iliac fossa

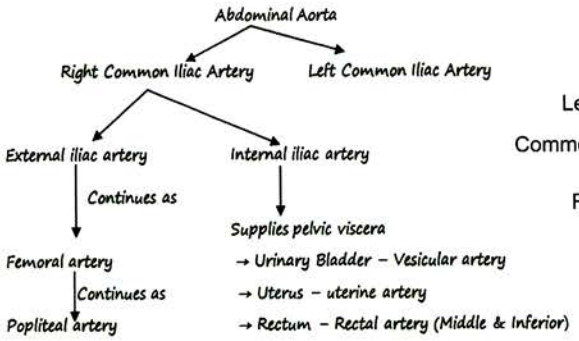


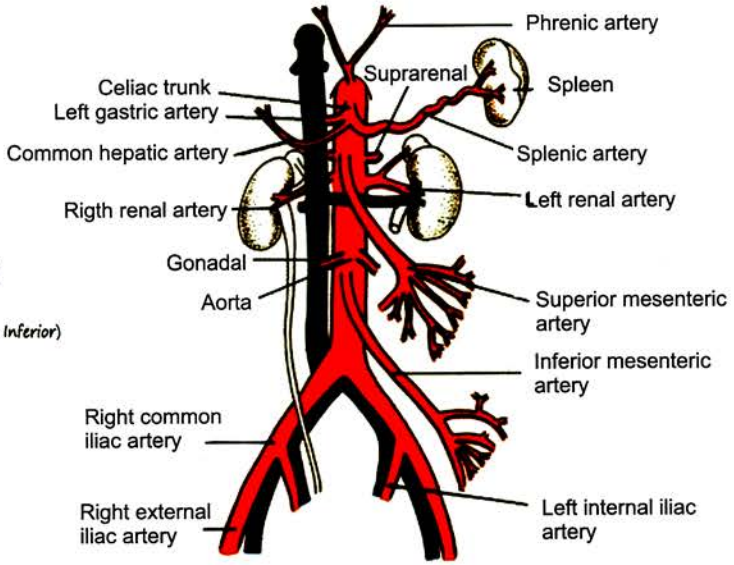
Thus, After 270 Rotation

Colon Has 4 Parts	Duodenum Has 4 Parts
→ Ascending colon	→ 1st part
→ Transverse colon	→ 2nd part
→ Descending colon	→ 3rd part
→ Sigmoid colon	→ 4th part

Abdominal Aorta & Its Branches

- → Extends from (T_{12} to L_4)
- → At L_4 vertebra, Abdominal Aorta bifurcates into 2 common iliac arteries





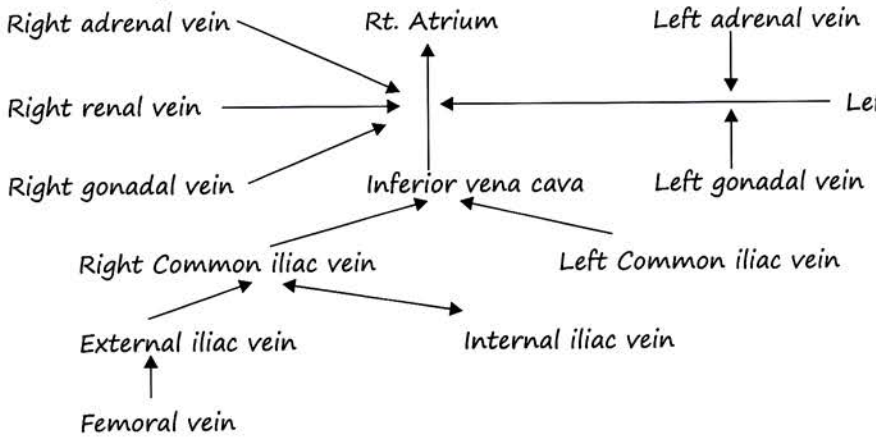
Anterior Branches

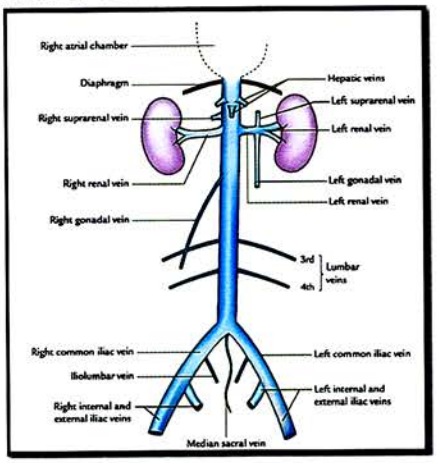
- → Celiac trunk – Foregut
- → Superior mesenteric artery – Midgut
- → Inferior mesenteric artery – Hindgut

Notes

- → Gonadal arteries aren't the Branches of Internal Iliac artery. (They are the direct branches of Abdominal Aorta below renal arteries)
- → In IUL, kidney are the pelvic organs, so supplied by common iliac artery. But later, as they ascends up, they are supplied directly by abdominal aorta.

Venous Drainage





→ Right sided adrenal vein
→ Right sided renal vein
→ Right sided gonadal vein
} Drains separately into the inferior vena cava

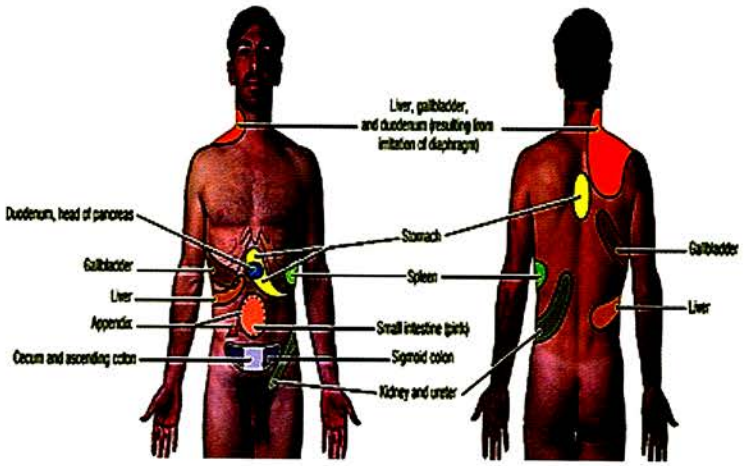
→ Left sided adrenal vein
→ Left sided gonadal vein
} Drains into Left Renal vein
↓
Which further drains into inferior vena cava

Pain

→ Gut pain is always in the middle unless there is localised area involved
→ Eg. Acute appendicitis → Periumblical Pain – T_{10}
(If localized peritonitis present, right Iliac fossa pain will be there).

Referred Pain

→ Acute cholecystitis – Right shoulder tip
– Phrenic nerve (C_4)
→ Splenic rupture – Left shoulder tip
– Phrenic nerve (C_4)
→ Pain of foregut – Epigastrium – T_7
→ Pain of midgut - Periumblical – T_{10}
(Eg. Acute appendicitis)
Or Meckel's diverticulitis)
→ Hindgut pain – Suprapubic area – L_1
→ Kidney pain – Loin to groin – L_5 (T_{12+2})
Loin pain – d/t T_{11} – T_{12}
Groin pain – d/t L_1 – L_2 (Involving the anteromedial part of the thigh)

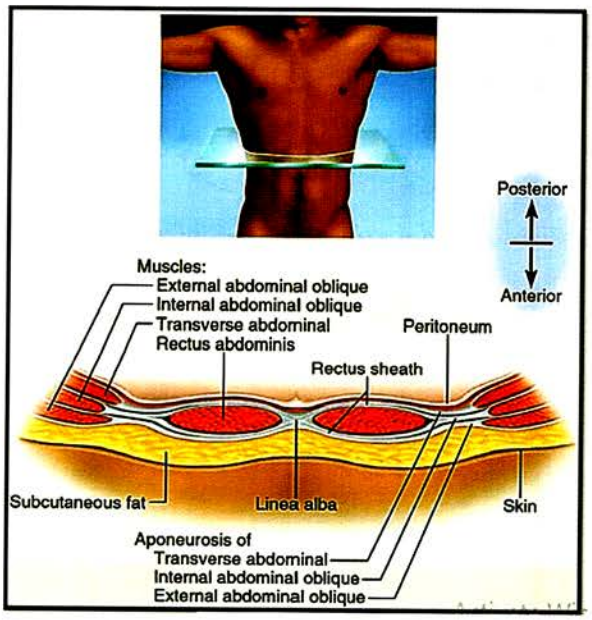


Layers Of Anterior Abdominal Wall

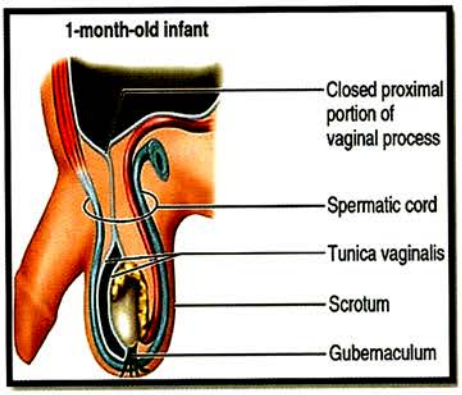
→ Skin
→ FASCIA
→ MUSCLES
- External oblique muscle (Outermost)
- Internal oblique muscle
- Transverse Abdominis muscle (Innermost)

These muscles insert into fascia known as "**RECTUS SHEATH**" which encloses the "**RECTUS ABDOMINIS MUSCLE**"

→ External oblique muscle – forms anterior layer of Rectus sheath
→ Internal oblique muscle – splits into two (1 goes anterior to Rectus abdominis & other goes posterior to Rectus abdominis muscle upto **Arcuate Line**)
→ Transverse abdominis – posterior layer of Rectus sheath.

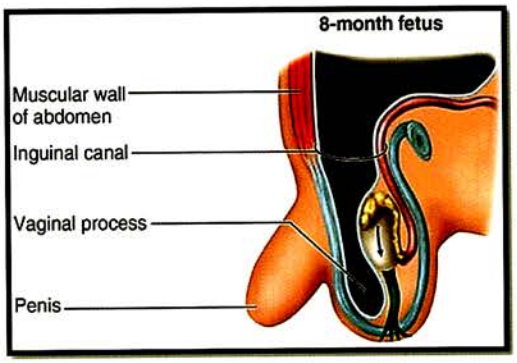


→ They fuses in the midline known as linea alba
→ Below the Arcuate line – posterior layer of Rectus sheath is absent



Testis Development

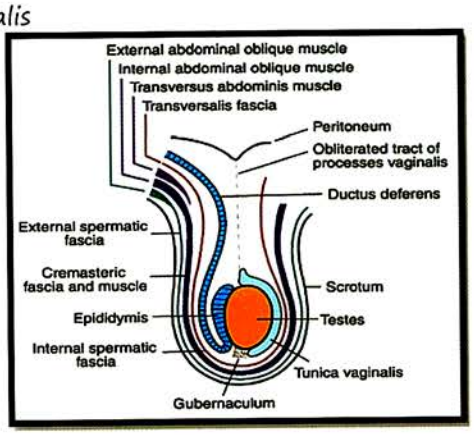
→ Testis – development starts 7th day of IUL in abdomen
→ Testis descends into pelvis 3rd month of IUL
→ Pulled down by Gubernaculum to the base of scrotum in front of pubic symphysis in the inguinal region, followed by double fold of peritoneum known as "**Processus Vaginalis**"



→ In 8th month of IUL, testis enters into the scrotum followed double fold of peritoneum, which is now known as "**Tunica Vaginalis**".
→ Thus, anterior abdominal wall layers and Tunica vaginalis covers the testis in the scrotum and spermatic cord
→ Spermatic cord contains
- Ductus deferens
- Testicular vessels

Notes

→ Testis is fully present in the scrotum just before birth (at the end of 9 months of gestation)
→ Fully covered by double fold of peritoneum known as Tunica vaginalis
→ Processus vaginalis is fully oblilterated normally to avoid entry of intestine into the scrotum, leading to INDIRECT INGUINAL HERNIA.

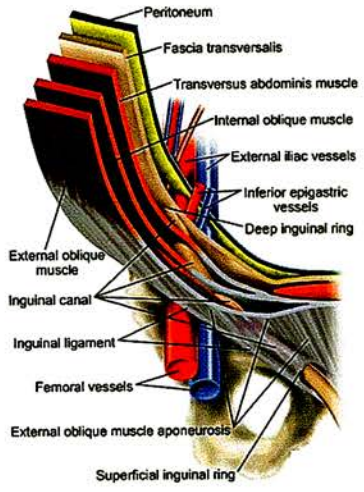


Covering of Spermatic Cord

Abdominal Structure	Derivative In Spermatic Cord
External oblique oponeurosis	→ External spermatic fascia
Internal oblique muscle	→ Cremaster muscle
Transversalis fascia	→ internal spermatic fascia
Peritoneum	→ Processus vaginalis

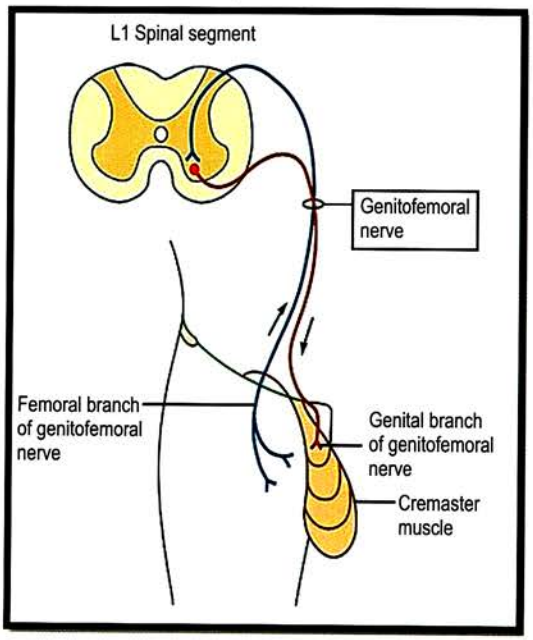
Inguinal Canal

→ External oblique aponeurosis → has superficial inguinal ring (Forms external spermatic fascia in spermatic cord)
→ Internal oblique muscle – forms anterior wall, Roof, Posterior wall of inguinal canal
→ Transversus abdominis – forms Roof & posterior wall
→ Internal oblique & Transversus abdominis fuse to form conjoint tendon
→ Transversalis fascia – present posteriorly, has deep inguinal ring
→ Transversus abdominis muscle doesn't contribute to the layers of spermatic cord



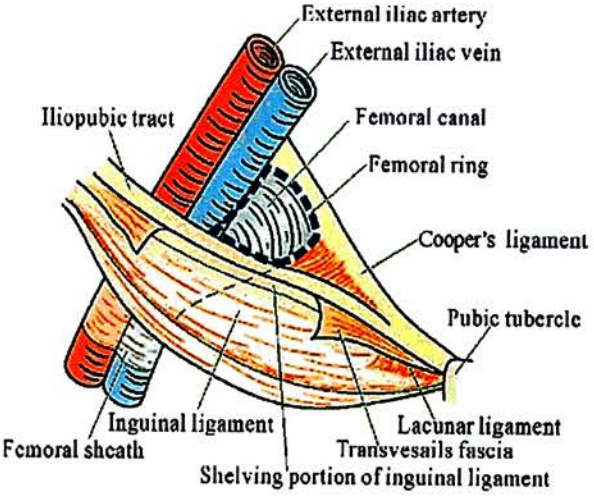
Cremasteric Reflex

Stroke on the upper medial aspect of thigh
↓
Stimulates the femoral branch of genitofemoral nerve (Sensory)
↓
Activates L_1 segment of spinal cord
↓
Send signals to genital branch of genitofemoral nerve (Motor)
↓
Activates cremastric muscle
↓
Uplift of the Ipsilateral testis
↓
k/a cremasteric Reflex



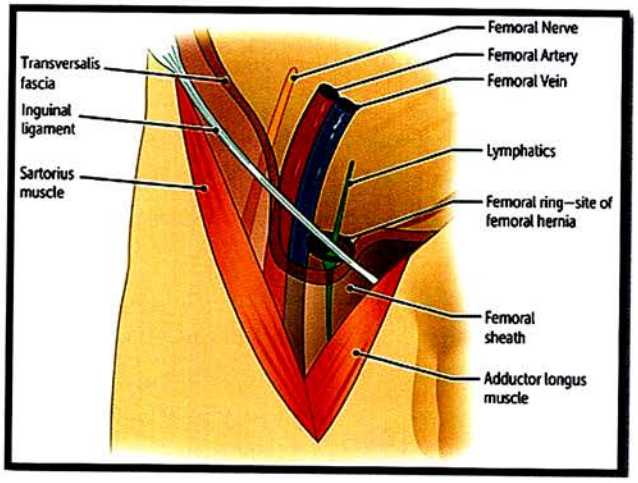
Boundaries of Femoral Ring

→ Anteriorly – Inguinal ligament
Posteriorly – Cooper's ligament
Medially – Lacunar ligament
Laterally – Femoral vein
→ To reduce the femoral hernia, **Lacunar Ligament** should be cut & mesh should be placed to prevent its recurrence



Femoral Triangle

Superiorly – Inguinal ligament (Base)
Laterally – Medial border of Sartorius muscle
Medially – Lateral border of Adductor longus muscle



Contents of Femoral Triangle (From medial to lateral)

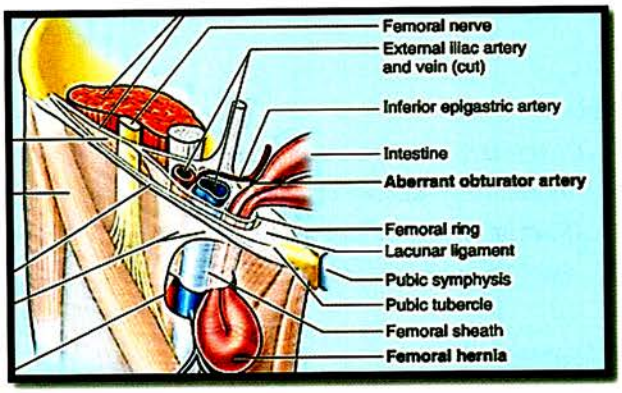
a) Lymphatics (Medial most)
b) Femoral Vein
c) Femoral Artery
d) Femoral Nerve

} Covered by femoral sheath

Notes

→ Descent of the intestine into the thigh via femoral ring is known as "**Femoral Hernia**"

→ External iliac artery continues as femoral artery & gives a branch "**Accessory Obturator Artery**" which runs onto the Rectus sheath. But in some cases, it runs on the lacunar ligament. So, care must be taken while cutting the lacunar ligament during the reduction of femoral hernia surgery.



Inguinal Hernia

→ Femoral Hernia – Neck lies below the inguinal ligament (Infero-lateral to the pubic tubercle)

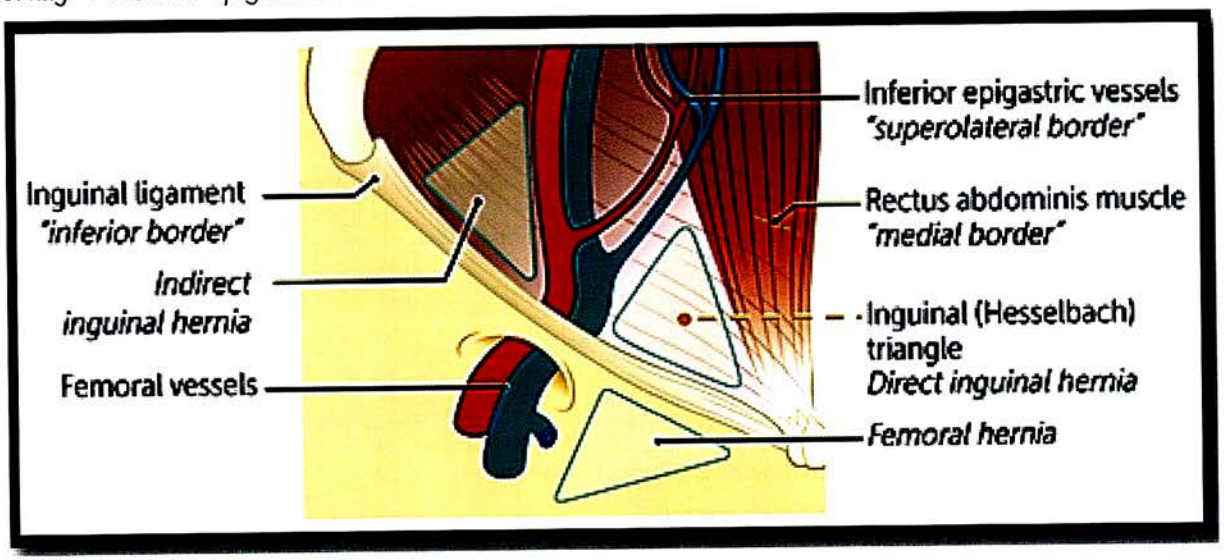
→ Inguinal hernia – Neck lies supero-medial to the pubic tubercle

Direct
- Elderly
- Lies medial to the inferior epigastric artery
- Passes via Hesselbach's triangle

Indirect
Young age
Lies lateral to the inferior Epigastric artery
Passes via deep inguinal ring, inguinal canal and superficial inguinal ring.

Boundaries of Hesselbach's triangle

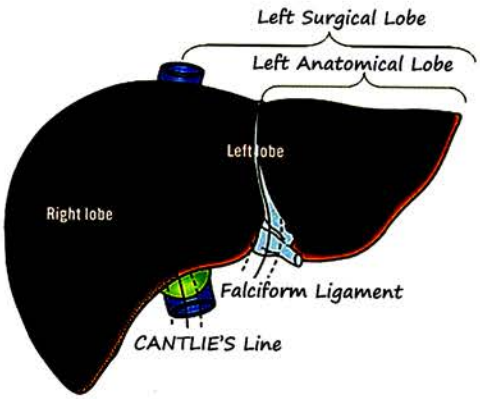
Inferiorly → Inguinal ligament
Medially → Lateral Border of rectus abdominis muscle
Laterally → Inferior epigastric vessels



Liver

Liver Transplantation

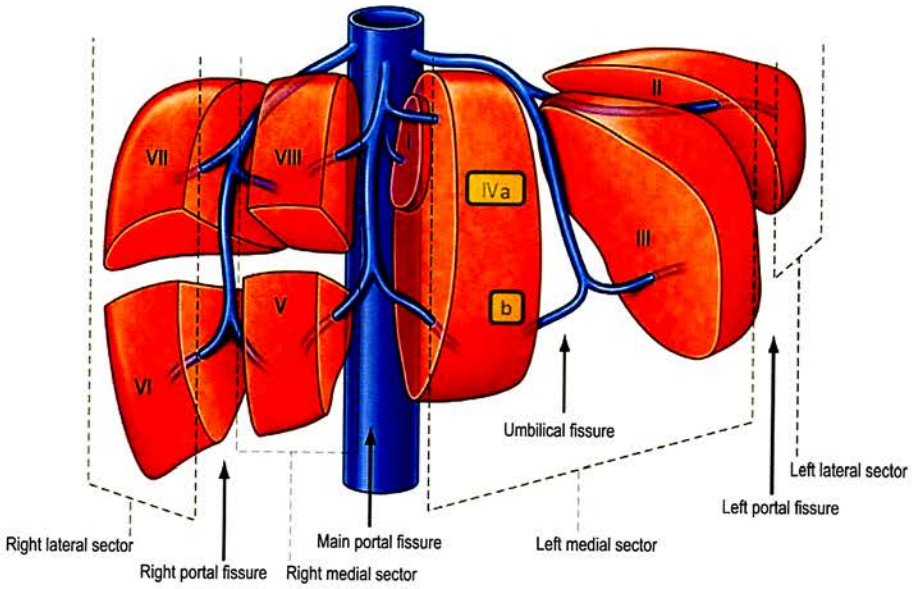
Liver has 2 lobes: Right surgical lobe (60-70%) – Recipient
Left Surgical lobe (30-40%) – Left in donor
↓
Divided by MIDDLE HEPATIC VEIN



Note

(CANTLIE'S LINE: Line joining midpoint of gall bladder to midpoint of inferior vena cava)
- Part of liver left to Falciform ligament of liver → Left Anatomical Lobe
  Part of liver left to Cantlie's Line of liver → Left Surgical Lobe

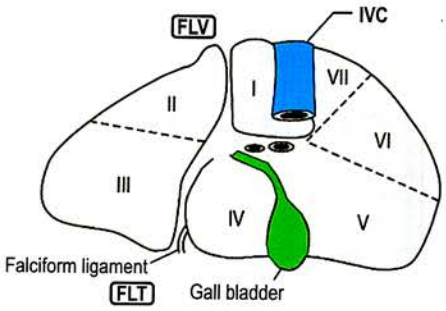
Segments Of Liver



→ Divided by Right Hepatic vein, middle hepatic vein & left hepatic vein (also called as Intersectoral veins)
→ Total, there are 4 sectors (Dissected by intersectoral veins) & 8 segments in the liver.
→ Intersectoral veins drains the metabolites from liver into inferior vena cava
→ Caudate lobe drains directly into the inferior vena cava, so gets escaped from injury in Budd Chiari Syndrome and liver cirrhosis.

Segment 1 = Caudate lobe of liver
Segment IV b = Quadrate lobe of liver
} Seen only from posterior view

Budd Chiari Syndrome is Hepatic vein Thrombosis & inability of liver to drain into IVC and there is reversal of Blood flow leading to Portal Hypertension in liver cirrhosis patients (Except caudate lobe, as it survives from the injury due to its direct drainage into IVC)



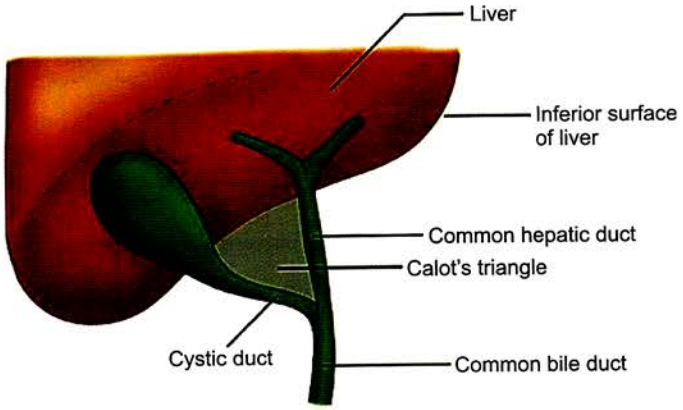
→ This will lead to compensatory hypertrophy of caudate lobe in liver cirrhosis & portal hypertension
→ Fissure for ligamentum venosum (FLV) – divides segment I & II
→ Fissure for ligamentum teres (FLT) – divides segment III & IV
→ To divide the segment II & III from rest of the liver, incision via FLV & FLT is made, which is an avascular plane.

Couinaud Classification

→ Liver is divided into 8 segments: Portal vein has to be followed for division (But, surgeons can follow hepatic veins also)
→ Segment I – (Smallest) caudate lobe
→ Segment II, III, IV – Left surgical liver (Drain bile into – Left Hepatic duct)
→ Segment V, VI, VII, VIII – Right Surgical liver (Drain bile into – Right Hepatic duct)
→ Segment I – Also called as 3rd surgical liver
– Drains bile into both (Right & Left) Hepatic duct

Calot's Triangle

Medially – Common Hepatic duct
Inferiorly – Cystic duct
Superiorly – Inferior Surface of the Liver



Note

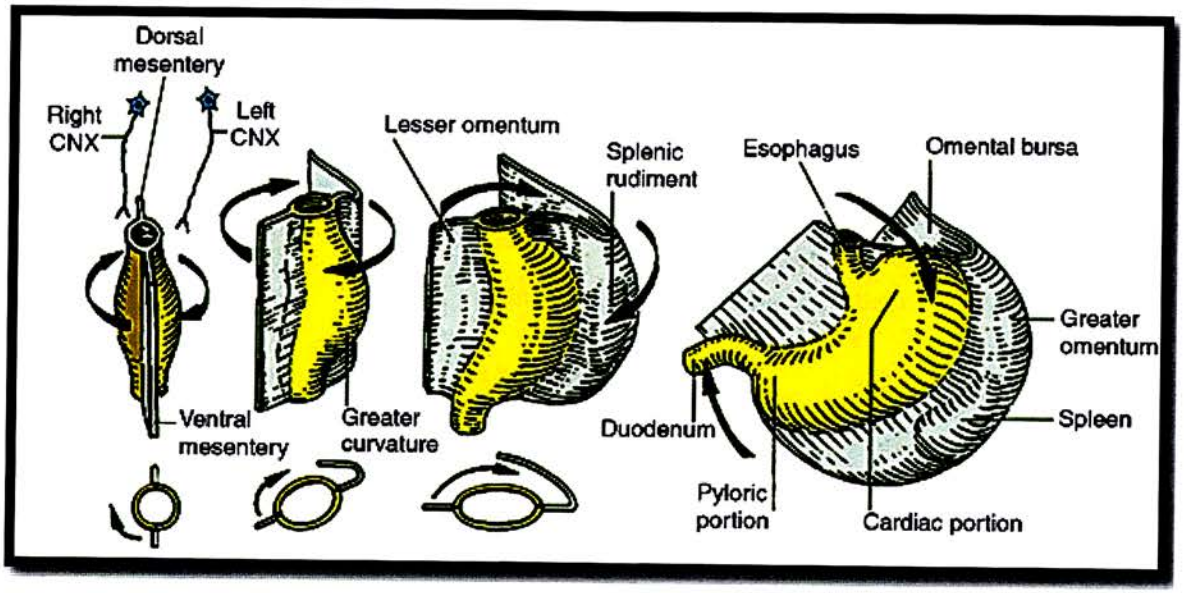
→ Hartmann's pouch (Present at the neck of Gall Bladder) is the most common site for the lodgement of Gall Stones.
→ Cystic duct has a spiral value named **"Valve of Heister"** which allows unidirectional flow of Bile towards common bile duct.

Stomach

→ Stomach Rotates About 90° Leading To

a. Rotation of liver to the right side by lesser omentum

b. Rotation of spleen to the left side by splenogastric ligament



→ As stomach rotates to 90°, a peritoneal space is created behind the stomach known as "**Lesser Sac or Omental Bursa**".

→ Posterior perforation of stomach leads to passage of gastric contents to the lesser sac.

Note → "**Epiploic Foramen of Winslow**" gives the way to reach to the lesser sac for the removal of gastric contents from the sac.

Greater Sac

→ It include recto uterine pouch of Douglas and Hepatorenal pouch of Morrison.

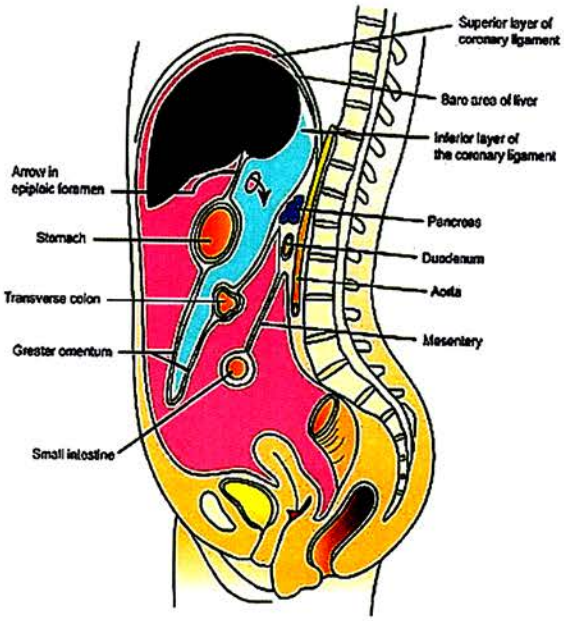
→ Boundaries of Epiploic foramen of Winslow

a. **Anteriorly** → Fold of peritoneum known as Lesser sac, DAV structures of porta hepatis (Running lesser omentum)

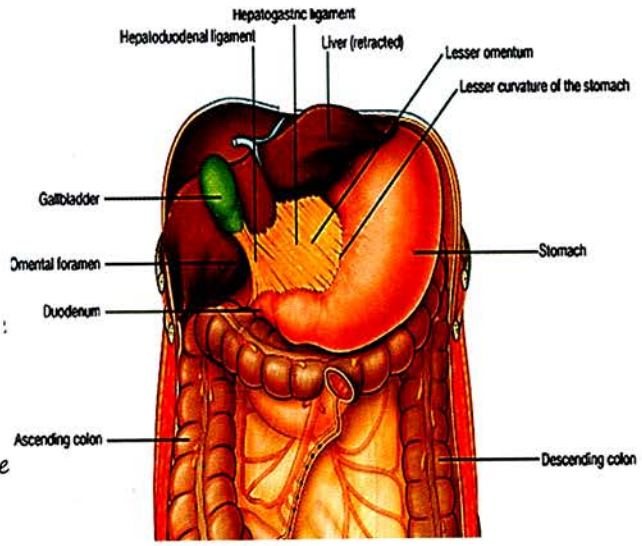
b. **Posteriorly** → T_{12} vertebra
→ Inferior Vena Cava
→ Right Adrenal Gland

c. **Superiorly** → Caudate lobe of liver

d. **Inferiorly** → First part of duodenum



Liver



a. Hepatogastric Ligament

→ Between liver & lesser curvature of stomach.

b. Hepatoduodenal Ligament

→ Between liver & 1st part of duodenum

→ It carries porta hepatis structures lying anterior to the foramen of winslow.

Note:

Pus collection in lesser sac postoperatively migrates to the MORRISON'S POUCH (Hepatorenal Pouch) in supine position (Most Dependant Location)

↓

Encourage ambulation of the patient causes migration of the pus from HEPATORENAL POUCH to the rectouterine POUCH OF DOUGLAS Via paracolic gutter due to gravity.

↓

Then, Pus is drained per vaginally in females & per rectally in males.

("**Pouch of Douglas**" → Most dependant location in a female with erect posture)

Pringle's Manduver

→Putting the finger through the foramen of winslow to pull the porta hepatis structures anteriorly to put the clamp during liver surgeries to minimize the bleeding.

Small and Large Intestine

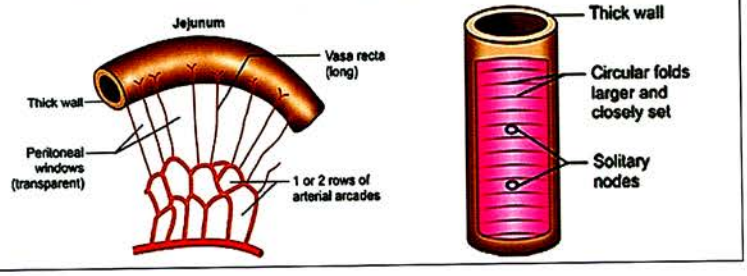
Small Intestine	Large Intestine
Have 3 features to increase the surface area of absorption. → Mucosal folds (Plicae Circularis) → Villi → Microvilli	Doesn't have these features ↓ So, Minimal absorption

Small Intestine

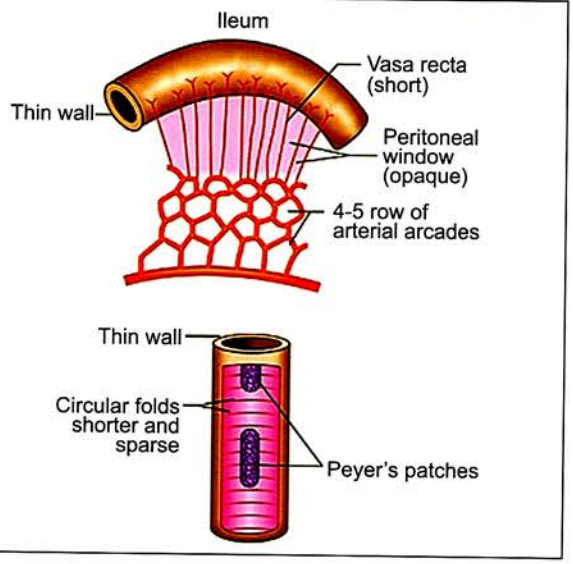
Jejunum

→ Plicae circularis more in number
→ Villi & microvilli more in number
→ Less lymphoid tissues
→ Less fat in the mesentry
→ Less number of vasa recta
→ Thick walled

Ileum



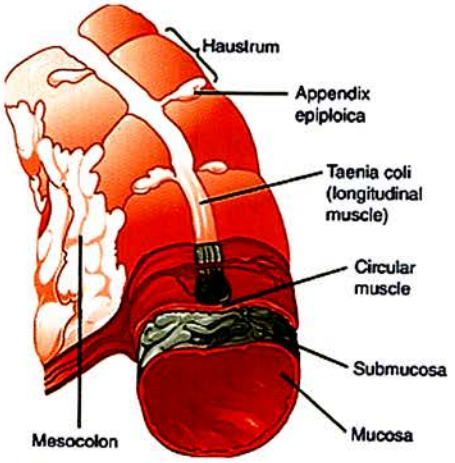
→ Plicae Circularis less in number
→ Villi & microvilli less in number
→ More lymphoid tissues
→ More fat in the mesentry
→ More number of vasa recta
→ Thin walled



Large Intestine

Features:

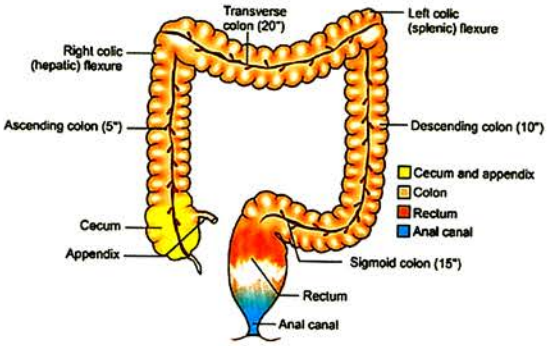
→ Alternate sacculations / Haustrations
→ Tinea coli
→ Appendices epiploicae (Peritoneal pouches with fat)



Parts of Large Intestine

→ Ascending colon (5")
→ Transverse colon (20")
→ Descending colon (10")
→ Sigmoid colon (15")

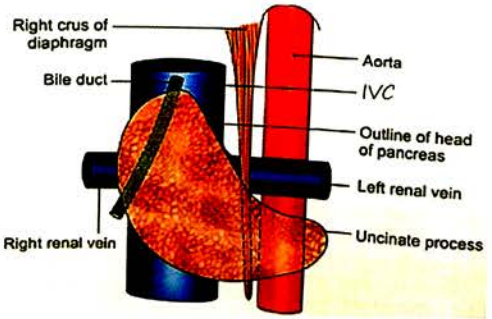
a. Caecum
b. Appendix
c. Rectum
d. Anal canal



Renal Hypertension

1. Left renal vein is longer than right renal vein (as it has to cross the midline to drain into inferior vena cava) behind the head of the pancreas.

2.IVC
Left Renal Vein
Right Renal Vein
Inferior Vena Cava
} Lies behind the "**Head**" of the pancreas.



Abdominal Aorta → Lies behind the "**Uncinate Process**" of the pancreas

Nut Cracker Syndrome

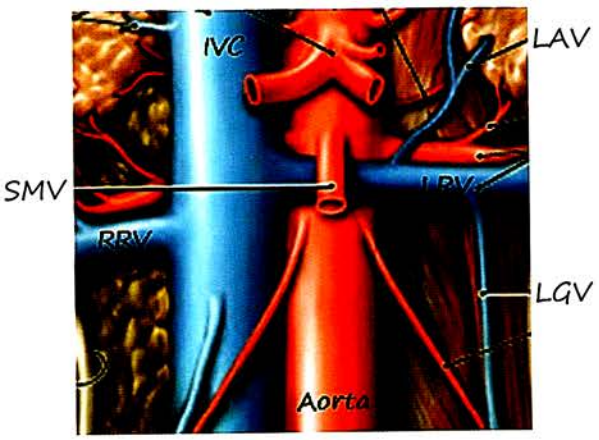
Compression of left renal vein between the Superior mesenteric artery (Anteriorly) & the abdominal aorta (Posteriorly)

↓

Leading to **Renal Hypertension**

↓

Further, backflow occurs to adrenal veins & left gonadal veins towards testes or ovary leading to "**Varicocele**" (Dilated, Elongated and Tortuous Veins)



Kidney

Anatomy:

→ Peripheral Cortex

→ Inner Medulla

Medullary Rays → Medulla extending towards cortex

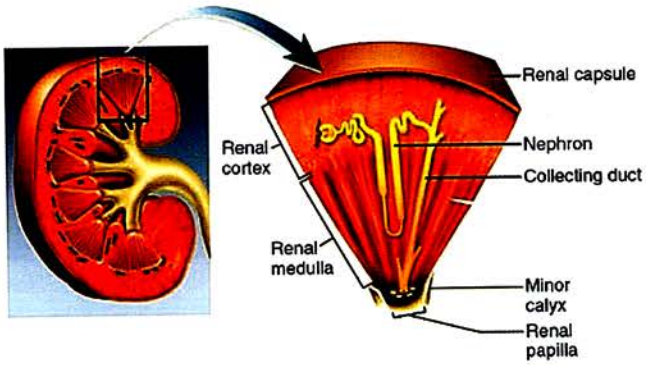
Cortex → Bowman's Capsule

PCT

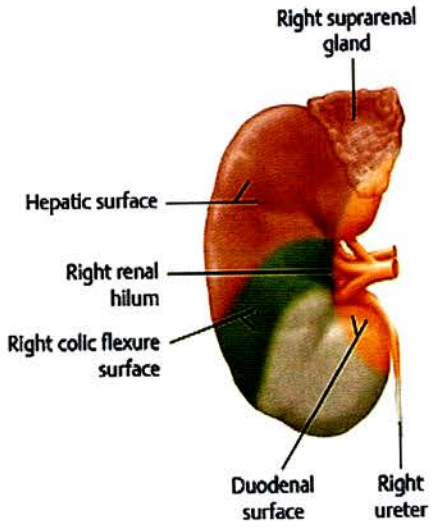
DCT

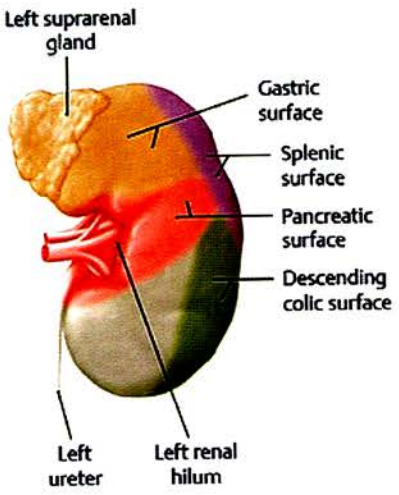
Medulla → Loop of Henle

→ Collecting duct

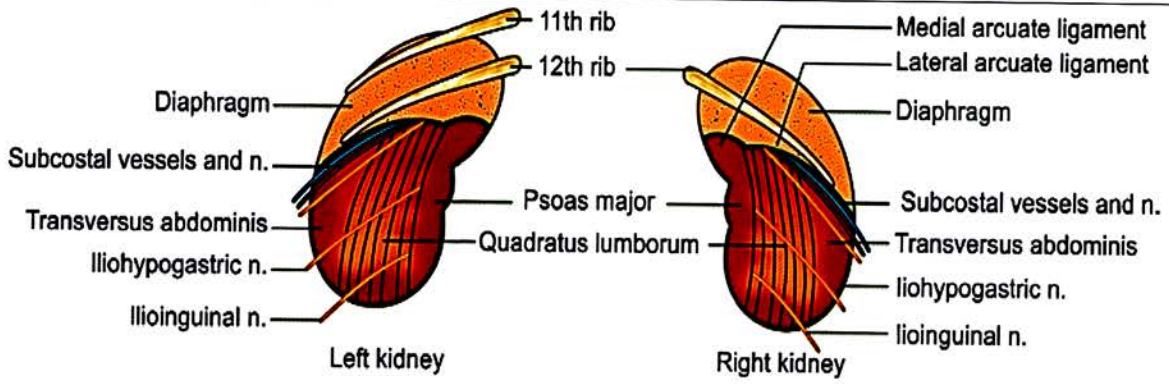


Anterior Relations of Right Kidney	Anterior Relations of Left Kidney
→ 2nd part of duodenum	→ Body of pancreas
→ Right adrenal gland	→ Spleen
→ Hepatic flexure of colon	→ Left adrenal gland
→ Liver	→ Splenic flexure of colon
→ Hepato-renal pouch of Morrison	→ Gastric area





Posterior Relations of Right Kidney	Posterior Relations of Left Kidney
→ 12th Rib (Due to downward push by liver)	→ 11th, 12th rib
→ Subcostal vessels & neurovascular bundle	→ Subcostal vessels & neurovascular bundle
3 Nerves	**3 Nerves**
→ Ilioinguinal nerve	→ Ilioinguinal nerve
→ Iliohypogastric nerve	→ Iliohypogastric nerve
→ Subcostal nerve	→ Subcostal nerve
3 Muscles	**3 Muscles**
→ Psoas major (Medial Most)	→ Psoas major (Medial Most)
→ Quadratus lumborum	→ Quadratus lumborum
→ Transversus abdominis muscles	→ Transversus abdominis muscles



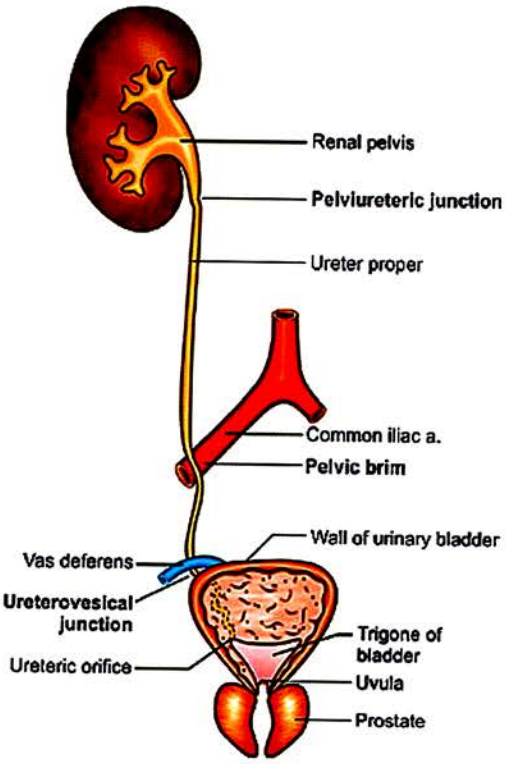
Urine Flow

Collecting Duct → Minor Calyces → Major Calyces → Renal Pelvis → Ureter → Urinary Bladder
↓
Urethra

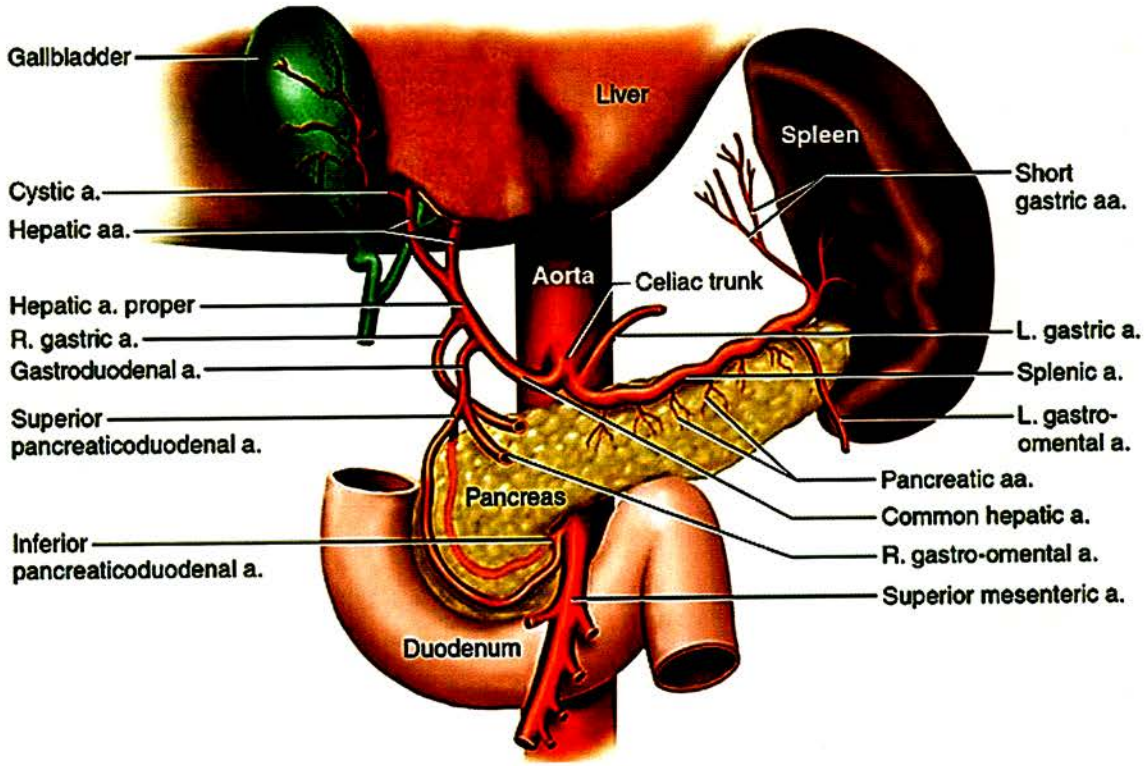
Ureter

Ureteric Constrictions

→ Pelviureteric Junction
→ At pelvic brim (at the bifurcation of common iliac artery)
→ At level of ductus deferens
→ At the site of insertion into urinary bladder.
(Ureterovesical Junction) – "**Narrowest**"
→ At the opening into the trigone of bladder



Abdominal Aorta



BRANCHES OF ABDOMINAL AORTA

A. Coeliac Artery (Artery of Foregut)

BRANCHES

1. **Left Gastric Artery** → To lesser curvature of stomach & lower 1/3rd of oesophagus
2. **Splenic Artery** → To spleen & pancreas & greater curvature of the stomach
3. **Common Hepatic Artery** → Supplies liver, stomach, duodenum, head of pancreas.

Note

a. Splenic artery gives short gastric & long gastric arteries which supplies greater curvature of stomach.

Short Gastric Artery → Carried by splenogastric ligament (Towards fundus)

Long Gastric Artery → Known as LEFT GASTROEPIPLOIC ARTERY (Towards the greater curvature in greater omentum)

b. Common Hepatic Artery: 2 branches

Proper Hepatic Artery → Further gives right & left hepatic (Goes towards liver) & supply caudate lobe. Right hepatic artery gives cystic artery which supplies gall bladder.

Gastroduodenal Artery

→ Passes behind 1st part of duodenum

→ Bleeds in case of posterior duodenal ulcer perforation

Branches of Gastroduodenal Artery

(i) Superior pancreaticoduodenal artery (Anastomoses with inferior pancreaticoduodenal artery)

(ii) Right gastroepiploic artery (Anastomoses with left gastroepiploic artery)

B. Superior Mesenteric Artery (Artery of Midgut)

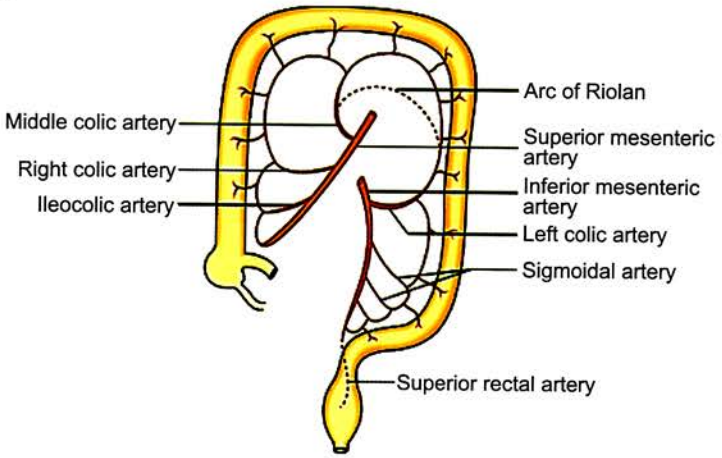
BRANCHES

1. **Ileocolic Artery** → Supplies terminal ileum & part of ascending colon, caecum, appendix
2. **Right Colic Artery** → Supplies ascending colon
3. **Middle Colic Artery** → Supplies transverse colon (2/3rd)

Arterial Circle of Riolan

Arterial Circle Of Riolan → Present in the cavity of large intestine

Watershed Area → At the junction of left 1/3rd & right 2/3rd of the transverse colon.
→ It is the site of least blood supply, so more prone for ischemia.
(As it is at the junction of middle colic artery & the left colic artery).



C. Inferior Mesenteric Artery (Artery of Hindgut)

BRANCHES

1. **Left Colic Artery**
   → Gives ascending branches: To descending colon & splenic flexure of colon
   → Sigmoidal arteries: To sigmoid colon
2. **Superior Rectal Artery**: Supply to the Rectum

Note Middle Rectal Artery, Inferior Rectal Artery } Direct Branches from internal iliac artery

→ Another Watershed Area: At the junction of superior & middle rectal artery (More prone for ischemia)

Venous Drainage

Inferior mesenteric rein drains into the splenic vein

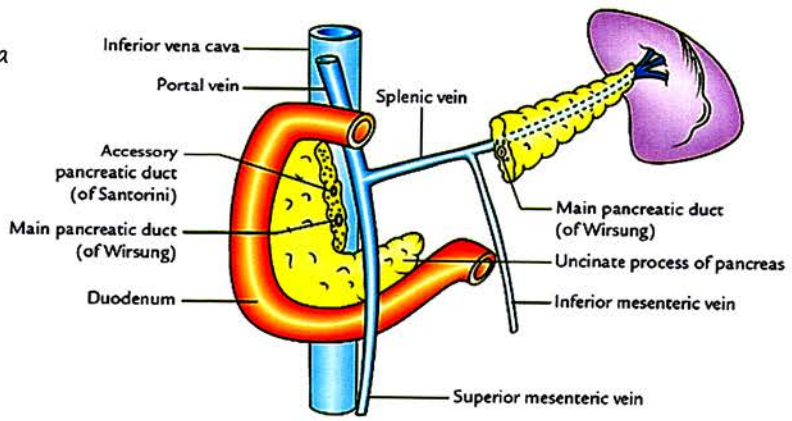
↓

Then splenic + superior mesenteric vein

Drains into the portal vein (behind bleed of pancreas)

↓

Which drains into inferior vena cava



Inferior Mesenteric Vein

→ Located in paraduodenal fossa

→ Thus, to be protected from injury during the surgeries for herniation

Normal Venous Blood Flow

IRV → IIV ← MRV

IIV → CIV ← CIV (Of Opposite Side)

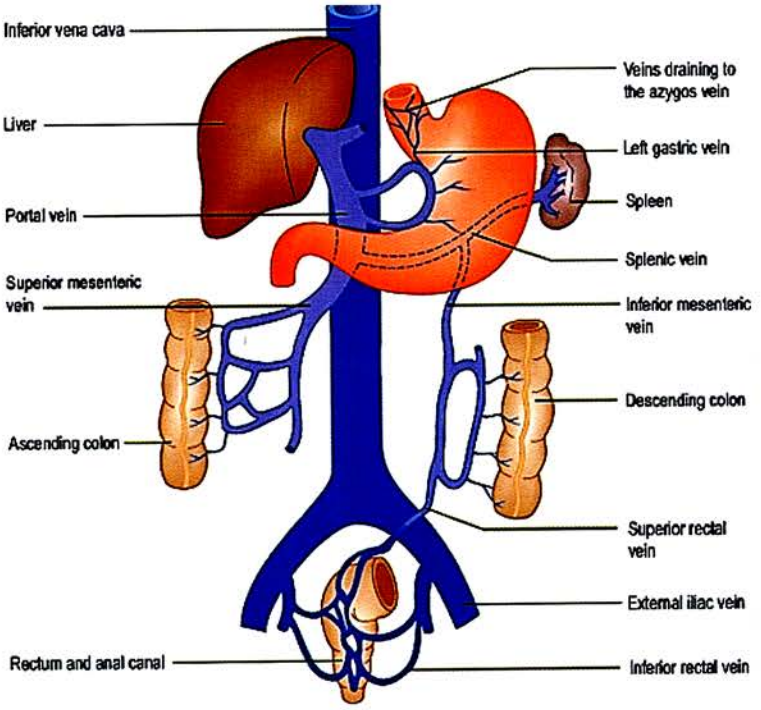
FV → EIV → CIV

CIV → IVC

SRN → IMV → SV → PV → IVC

SMV → PV → IVC

IVC → Drains Into Right Atrium



Note

In case of **Budd Chiari Syndrome** & **Portal Vein Thrombosis**

↓

Blood will not be able to drain into IVC

↓

Reversal of blood flow into the portal vein

↓

Portal Hypertension

Portosystemic Venous Shunt

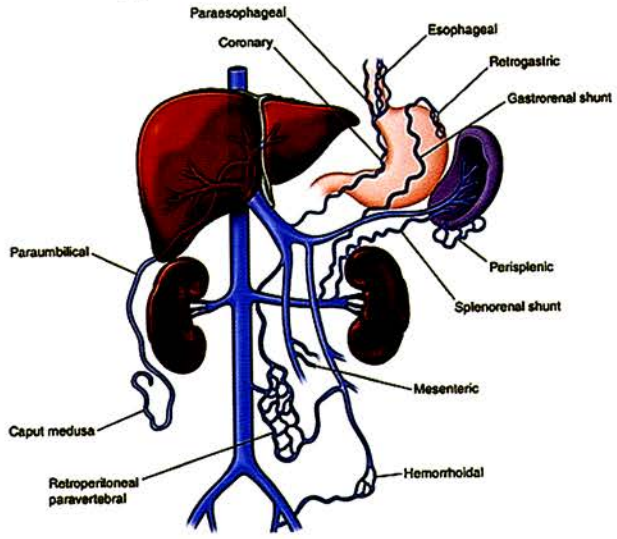
1. PV → Splenic Vein → Left Gastric Vein → Anastomosing with Oesophageal Vein → Blood jumping into the azygous vein

↓

"Oesophageal Varices"

↓

Massive Haematemesis



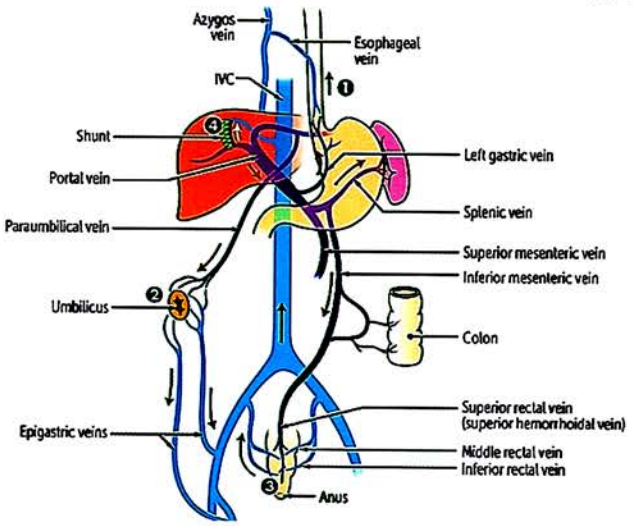
2. PV → SMV → SRV → Anatomosing with MRV, IRV

↓

Hemorrhoids ("**Rectal Varices**")

↓

Fresh Bleeding per rectum



3. Left Branch of Portal Vein → Paraumbilical vein

↓

Anastomosing with Systemic paraumbilical veins

↓

"Caput Medusae"

Note

→ Treatment: TIPSS (Transjugular Intrahepatic Portocaval Systemic Shunt)

↓

It shifts the blood from the portal vein towards the inferior vena cava

Transpyloric Plane

→ At the level of Lower border of L_1 Vertebra and tip of 9th costal cartilage

→ This level corresponds to:

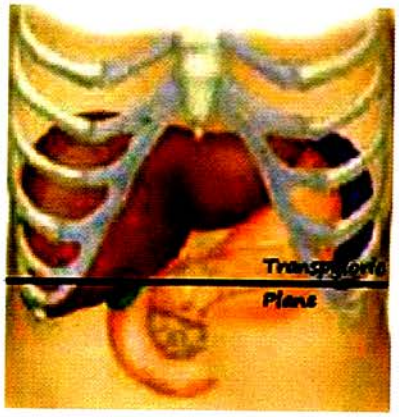
a. Pylorus of the stomach lies at this level

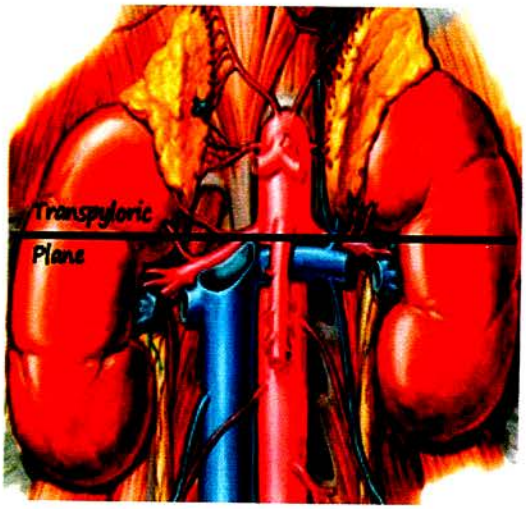
b. Aorta gives superior mesenteric artery & the renal artery.

c. Formation of portal vein

d. Hilum of both the kidneys

Termination of the spinal cord





Pelvis and Perineum

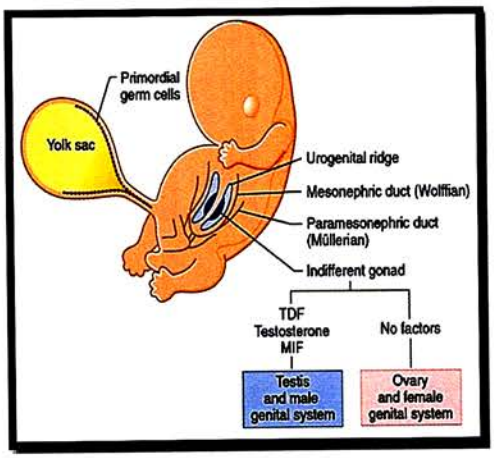
Development of genito urinary system

Intermediate mesoderm contributes to genito-urinary system

Female external Genitilia differentiation completed by **11 weeks.**

➔ Male external Genitilia differentiation completed by **14 weeks**

Y-chromosome ,sry gene Tdw6 Intermediate embryo



Y Chromosome

sry gene present on short arm

sry (sex region y chromosome) gene

codes for TDF (testis determining factor)

Genital ridge will develop at 5 week

testis starts developing at week 7

ovary starts developing at week 8

➔ **Sex determination not possible till W6 indeterminate embryo**

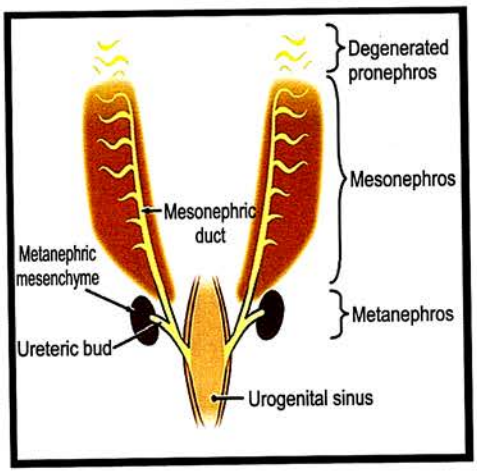
➔ **External genitilia differentiation completed after week 11**

➔ **USG sex differentiation can be done this time**

Development of Renal System

Urogenital ridge

Forms-Pronephros,Mesonephros,Metanephros



➔ **Kidney develop from metanephros**

➔ **Pro-nephros degenrated**

➔ **Mesonephros leaves behind mesonephric duct and degenerated**

➔ **Mesonephric duct gives uretric bud**

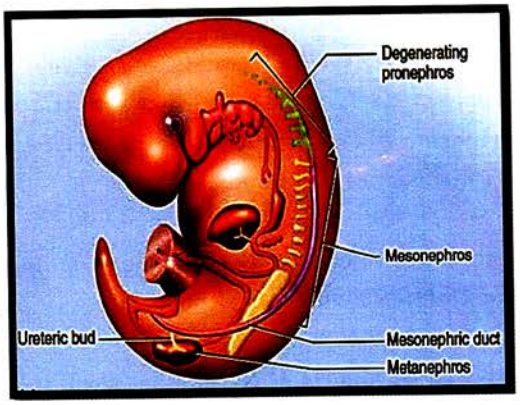
➔ **Ureteric bud stimulated metanephros to form the Kidney**

➔ **Urogenital sinus forms urinary bladder,urethra,lower vagina(2/3)**

➔ **The definitive kidney becomes functional at 12th week**

Tip of the mesonephric duct is absorbed into posterior wall of urogenital sinus forms trigone of urinary bladder.

1. Endoderm of urogenital sinus derivatives **urinary bladder,urethra, lower 2/3 vagina**
2. Mesonephric duct opens into post.wall of urogenital sinus in cloaca region.
3. **Ureter comes from ureteric bud**
4. Tip of mesonephric duct is absorbed into **posterior wall of urogenital sinus forms trigone** of urinary bladder, after this **mesonephric duct** is called as **wolffian duct.**
   Wolffian duct froms genital tube in males and regress in females giving **vestigial remnants**, eoophoron, paraoophron and **gartner duct.**

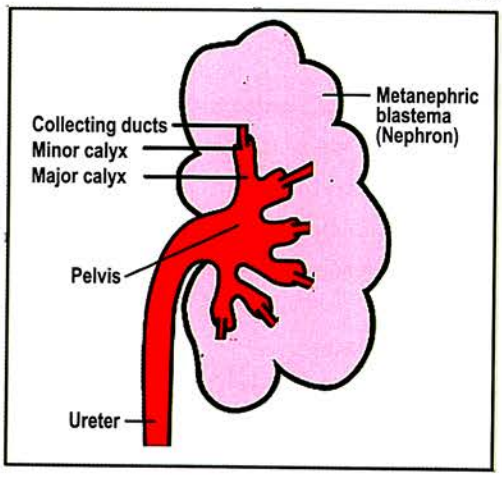


Ureteric bud derivatives

1. Ureter
2. Renal pelvis
3. Major calyx
4. Minor calyx
5. Collecting duct

Renal pyramid/medulla

Renal column of bertini part of cortex by the side of medulla



Embryo	Adult Derivative
Metanephric mesoderm Metanephric vesicles S-shaped renal tubules	Connecting tubule Distal convoluted tubule Loop of Henle Proximal convoluted tubule Renal (Bowman's) capsule Renal glomerulus
Ureteric bud	Ureter Renal pelvis Major calyx Minor calyx Collecting duct

Development of Genital Ducts

Para mesonephric (Mullerian ducts)

Cranial (unfused) portions of the paramesonephric ducts develop into the uterine tubes.
Caudal portions of the paramesonephric ducts fuse in the midline to form the uterovaginal primordium and thereby bring together two peritoneal folds called the broad ligament.

Uterovaginal primordium develops into the uterus, cervix, and superior 1/3 of the vagina.
Paramesonephric ducts project into the dorsal wall of the cloaca and induce the formation of the sinovaginal bulbs. The sinovaginal bulbs fuse to form the solid vaginal plate, which canalizes and develops into the inferior two-thirds of the vagina.

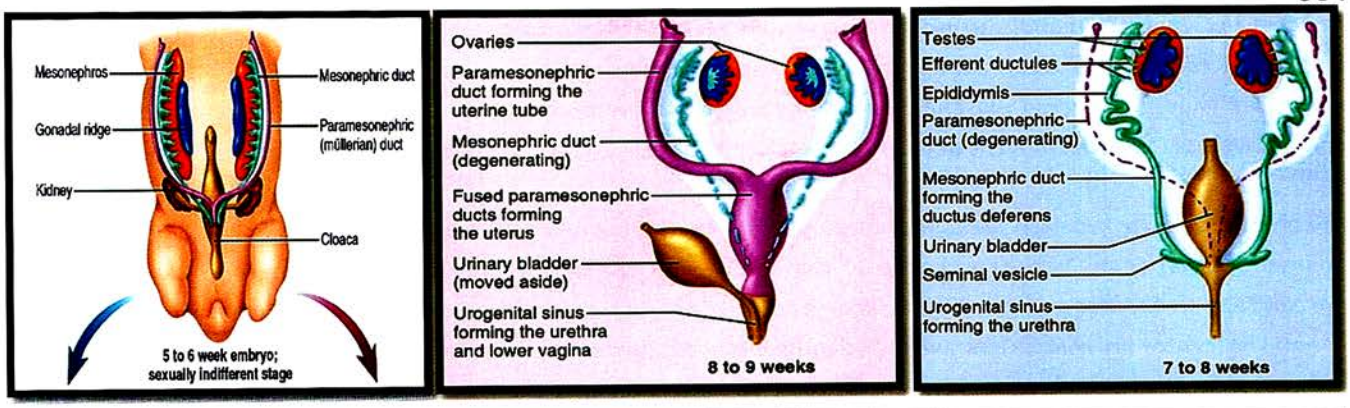
Vestigial remnants of the paramesonephric duct may be found in the adult female and are called the hydatid of Morgagni.

Mesonephric (Wolffian) ducts and tubules

Mesonephric ducts develop in the female as part of the urinary system because these ducts are critical in the formation of the definitive metanephric kidney. However, they degenerate in the female after formation of the metanephric kidney.

Vestigial remnants of the mesonephric ducts may be found in the adult female called the appendix vesiculosa and Gartner's duct.

Vestigial remnants of the mesonephric tubules are called the epoophoron and the paroophoron.

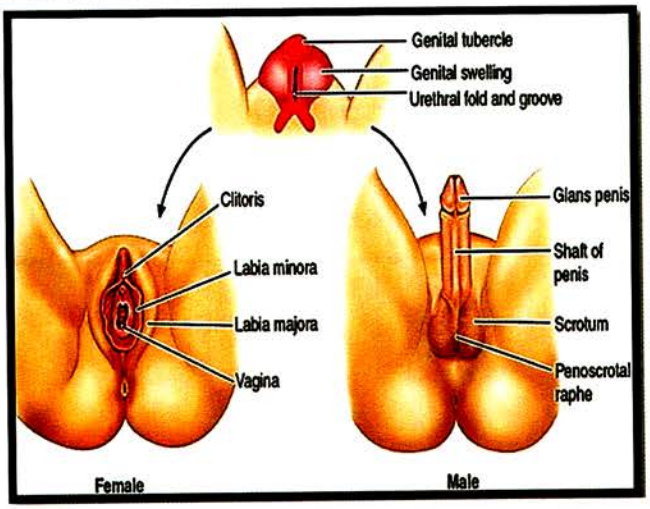


External Genitilia *Develops from dorsal somatic Lateral plate mesoderm*

Genital tubercle *forms clitoris in female, glans penis in male*

Genital fold *forms labia minora in female, Penoscrotal raphae in male*

Genital swelling *Forms scrotum in male Labia majora in female*



Indifferent Structure	Female	Male
Genital ridge	Ovary	Testis
Primordial germ cells	Ova	Spermatozoa
Sex cords	Granulosa cells	Seminiferous tubules, Sertoli cells
Gubernaculum	Uteroovarian and round ligaments	Gubernaculum testis
Mesonephric tubules	Epoöphoron, paroöphoron	Efferent ductules, paradidymis
Mesonephric ducts	Gartner duct	Epididymis, ductus deferens, ejaculatory duct
Paramesonephric ducts	Uterus, fallopian tubes, upper vagina	Prostatic utricle, appendix of testis
Urogenital sinus	Bladder, urethra	Bladder, urethra
	Vagina	Prostatic utricle
	Paraurethral glands	Prostate glands
	Greater (Bartholin) and lesser vestibular glands	Bulbourethral glands
Genital tubercle	Clitoris	Glans penis
Urogenital folds	Labia minora	Floor of penile urethra
Labioscrotal swellings	Labia majora	Scrotum

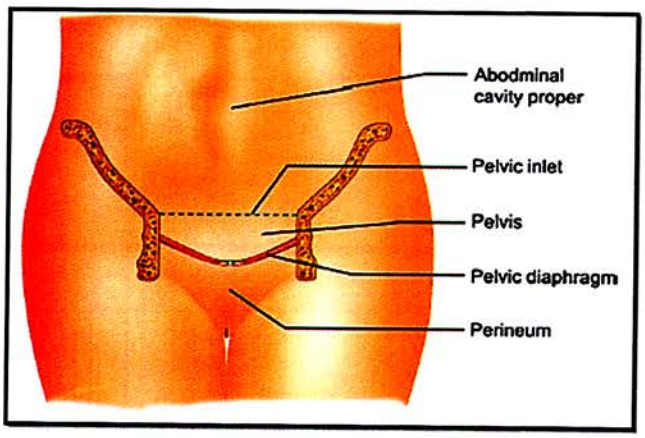
Boundary line between pelvis and perineum

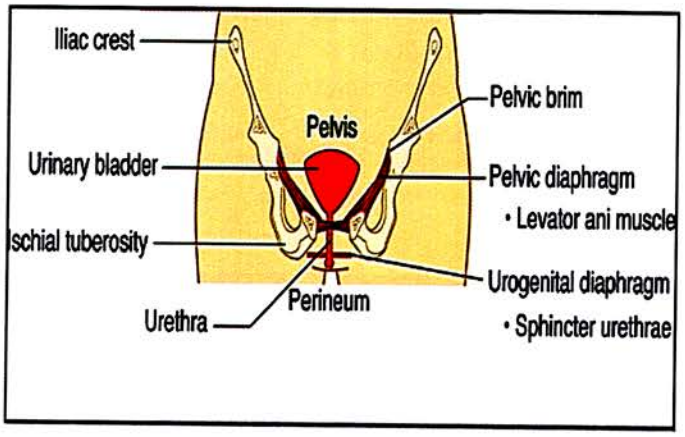
Pelvic diaphragm *separates the pelvic cavity above from the perineal region below. It lies posterior and* ***deep to the urogenital diaphragm*** *and medial and deep to the ischiorectal fossa. It forms the* ***pelvic floor and supports all of the pelvic viscera.*** *On contraction, raises the entire pelvic floor.*

It flexes the anorectal canal **during defecation** and helps the voluntary control of micturition.It helps direct the fetal **head toward the birth canal at parturition**. It is composed of muscle fibers of the **levator ani** and the **coccygeus** muscle (covered by the **parietal pelvic fascia** on their upper and lower aspects), and associated connective tissue which span the area underneath the pelvis.

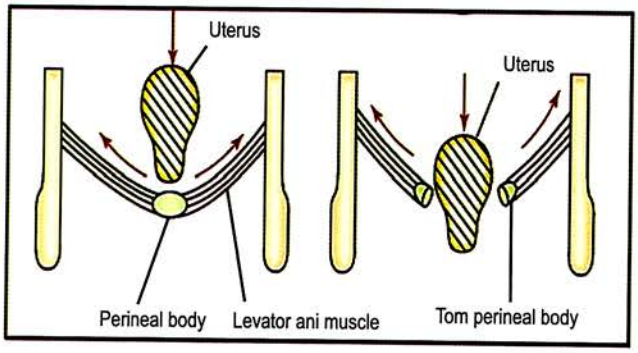
These muscles arise between the symphysis and the ischial spine and converge on the coccyx and the anococcygeal ligament which spans between **the tip of the coccyx and the anal hiatus.Right and left levator ani** lie almost horizontally in the floor of the pelvis, separated by a narrow gap that transmits the urethra, vagina, and anal canal. **The levator ani muscle has two parts**: pubococcygeus (anterior) and iliococcygeus (posterior).
Pubococcygeus runs backward from the body of the **pubis toward the coccyx**. Some fibers are inserted into the prostate, urethra, vagina & anorectal junction and named accordingly: puboprostaticus, pubourethralis, pubovaginalis, puborectalis respectively. Iliococcygeus attaches to the ilium part of hip bone and coccyx bone lies posteriorly and is **not well developed.**

Ischio-coccygeus **(simply called coccygeus)** is situated behind the levator ani and frequently tendinous as much as muscular, extends from the ischial spine to the lateral **margin of the sacrum and coccyx.**



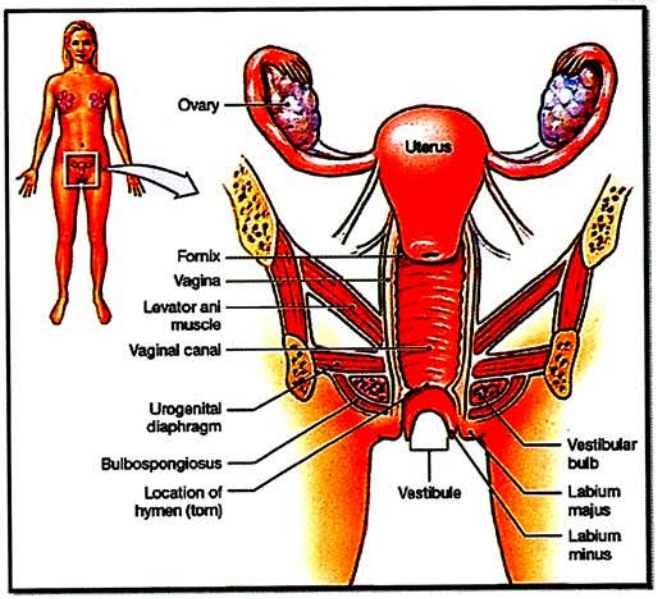


Perineal body (central perineal tendon) is the fibromuscular tissue located in the midline at the junction between the anal and urogenital triangles, just anterior to the anal sphincter.
In males, it is found between the bulb of penis and the anus and in females, it is present between the vagina and anal canal, and about 1.25 cm in front of the anus.



Structures attaching to perineal body:
External anal sphincter; Bulbospongiosus muscle; Superficial and deep transverse perineal muscle; Anterior fibers of the levator ani (including puborectalis or pubovaginalis etc.); Fibers from external urinary sphincter; Conjoint longitudinal coat (of rectum).
Perineal body is an important support of pelvic viscera and is essential for the integrity of the pelvic floor.
Perineal body tear during vaginal delivery leads to widening of the gap between the anterior free borders of levator ani muscle of both sides, thus predisposing the woman to **prolapse** of pelvic viscera (urinary bladder, uterus, rectum etc.)

Perineal pouches



Superficial Perineal pouch

- ➔ Present below colles fascia
- ➔ Contents
  - Bulbospongiosus

Deep perineal pouch

- ➔ Contains
- Urogenital diaphragm
- Deep transverse perineal muscle

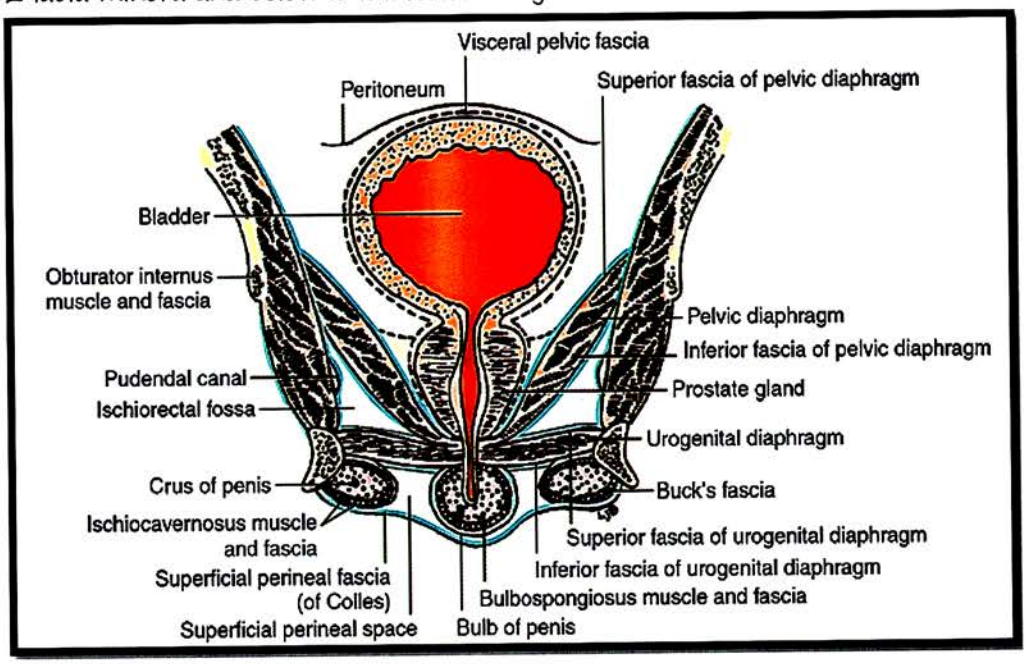
Contributes to urogenital diaphragm

Vestibule-

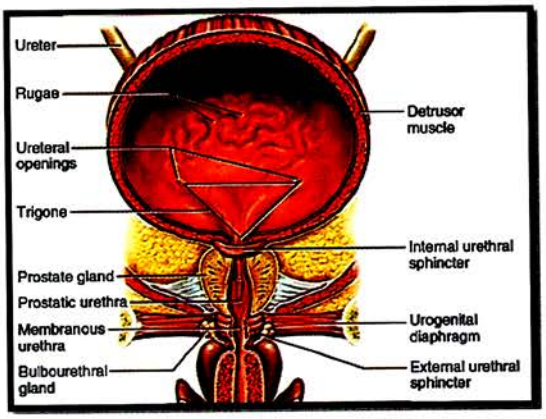
-Present in vulva of female

-Urethra and vagina opens here

-Bounded by 2 labia minora and below and inferior to hymen



Urinary Bladder and Urethra



Trigone of the bladder is located on the posterior surface of the bladder (**fundus or base**). Its limits are defined superiorly by the openings of the ureters and inferiorly by the internal urethral orifice, around which is a thick circular layer called the internal urethral sphincter (**sphincter vesicae**). It is always **smooth-surfaced** because the mucosa is tightly adherent to the **detrusor** muscle.

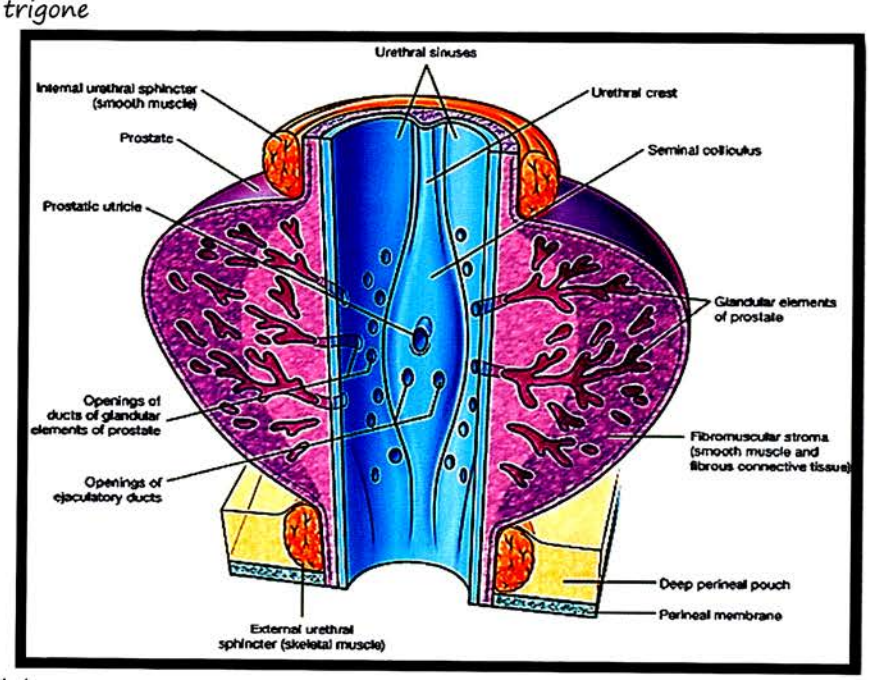
Uvula vesicae, which is a small eminence at the apex of its trigone, projecting into the orifice of the urethra.

Midline elevation on posterior wall of prostatic urethra **urethral crest**,d/t insertion of trigone till seminal colliculus/veromontanum rounded elevation).

➔ Verumontanum has 3 openings

1.Prostatic utricle opening

2.Ejaculatory duct opening



Internal urethric sphincter

Well developed in male and poorly developed in female.

➔ Smooth muscle sphincter prevents retrograde ejaculation of semen into bladder

External urethral sphincter

well developed in both sexes

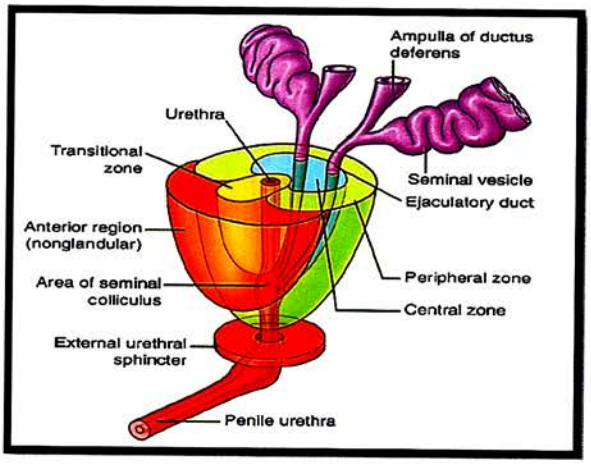
skeltal muscle sphincter to hold urine at own will supplied by pudendal nerve

Pudendal nerve block **urinary incontinence occurs**, before giving pudendal nerve block,empty urinary bladder by Foleys catheter and also give rectal enema (external anal sphincter is also controlled by pudendal nerve)

Zones of prostate

Transition zone It surrounds the proximal urethra (periurethral zone) and grows throughout life and is responsible for the benign prostatic hypertrophy. ~10–20% of prostate cancers originate in this zone.

Central zone It lies posterior to urethra and surrounds the ejaculatory ducts, accounts for ~2.5% of prostate cancers.



Peripheral zone The sub-capsular portion of the posterior aspect of the prostate gland that surrounds the distal urethra and is prone to cancer.

Anterior fibromuscular zone It has fibromuscular components only (glandular components absent)

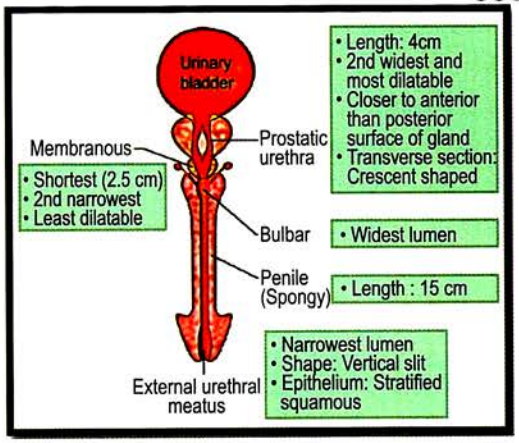
Parts of Male urethra

Male urethra consists of three parts: prostatic, membranous, and spongy

Prostatic urethra courses through and is surrounded by the prostate gland.

Membranous urethra courses through the urogenital diaphragm (deep perineal pouch) where it becomes related to the deep transverse perineal muscle and sphincter urethrae muscle

(external urethral sphincter), both of which are skeletal muscles innervated by the pudendal nerve. Spongy urethra has two parts; Bulbous and penile Bulbous spongy urethra courses through the bulb of the penis and develops endodermal outgrowths into the surrounding mesoderm to form the bulbourethral glands of Cowper.
Note: The glands are present in males in relation with membranous urethra (in the deep perineal urethra (in superficial perineal pouch).

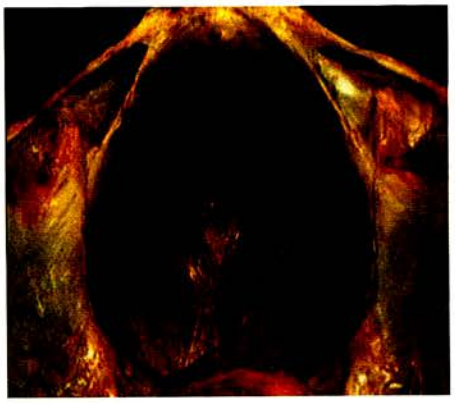


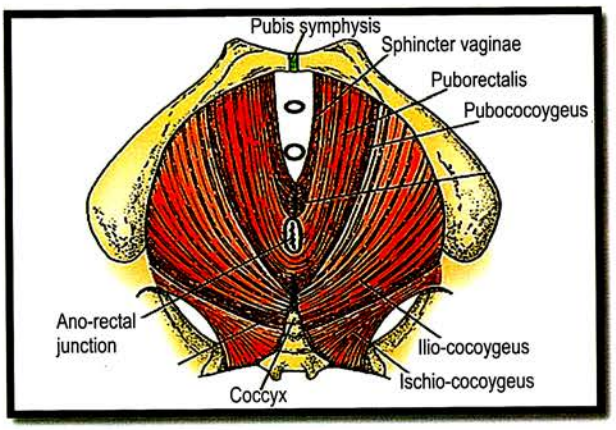
Penile spongy (cavernous) urethra courses through and is surrounded by the corpus spongiosum. Distal part of the penile urethra courses through the glans penis and terminates as the navicular fossa at the external urethral orifice. Prostatic urethra and the membranous urethra together are considered as the posterior urethra and bulbous urethra plus the penile urethra are called the anterior urethra.

The narrowest lumen is present at the external urethral meatus and the second narrowest is in the membranous urethra. The widest lumen is present in the bulbous part of penile urethra, second widest is the prostatic urethra.

Female uro-genital diaphragm

3 parts of hip bone- Pubis anterior, ileum lateral, sacrum and coccyx bone Pelvic diaphragm muscle which support pelvic viscera.



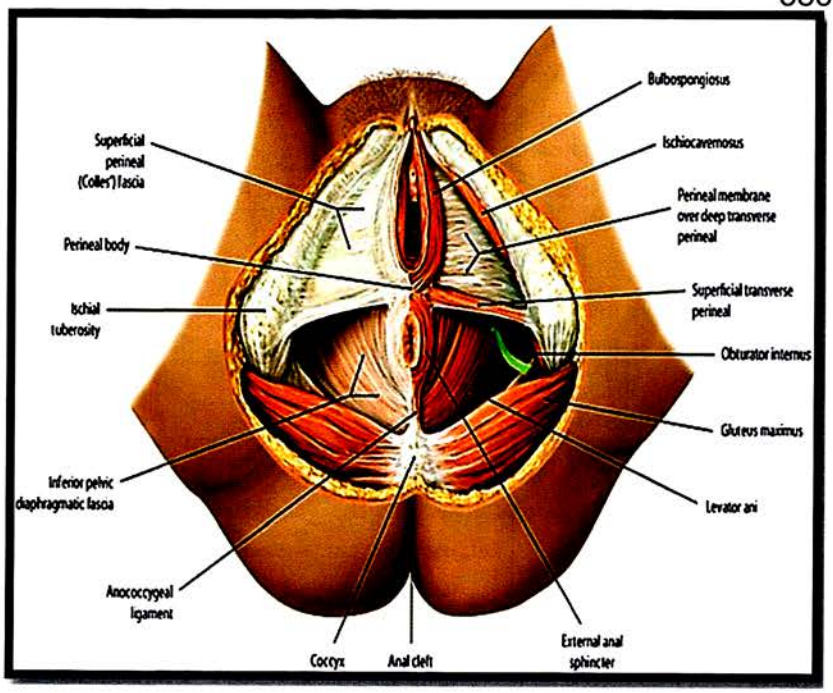


Pelvic diaphragm is contributed by **levator ani (pubococcygeus and Iliococcygeus)** and ischiococcygeus muscles. Parts of pubococcygeus: pubourethralis, puboprostaticus, pubovaginalis, puborectalis are components of the diaphragm. Ischiococcygeus (coccygeus) lies immediately cranial to levator ani and is contiguous with it, but is not a part of levator ani muscle.

Female in lithotomy position

.Ant bone- pubic bone
post bone- sacrum and coccyx
Lateral bone- ischial tuberosity
Antero-lateral- ischiopubic ramus

glands clitoris comes from genital Tubercle
Labia Minora comes from genital fold
hymen-membrane covers the vaginal Opening partially
vestibule urethra and vagina opens,
Bounded by 2 labia minora below hymen.



Ischia-rectal fossa

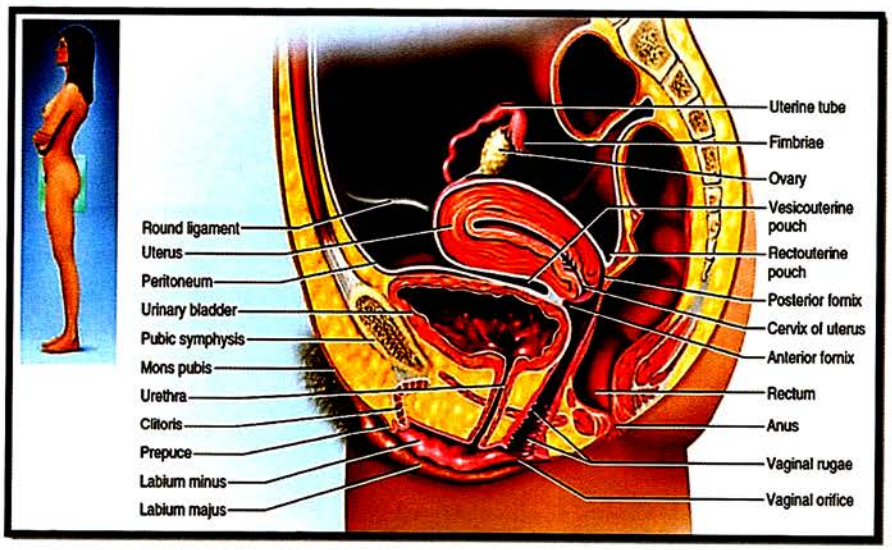
Space between ischial bone laterally and anus/rectum in midline
Hip bone
Parts
Pubic bone Ant
Ilium lateral
Ischium Posterior
Prone to ischiorectal abscess

Boundary

Medial Levator ani muscle
Lateral Ichium bone with obturator internus muscle and obturator facia and pudendal canal (pudendal neurovascular bundle in it)
Anterior Perineal membrane with superior transverse perineal muscle
Posterioro sacro-tuberous ligament with gluteus maximus

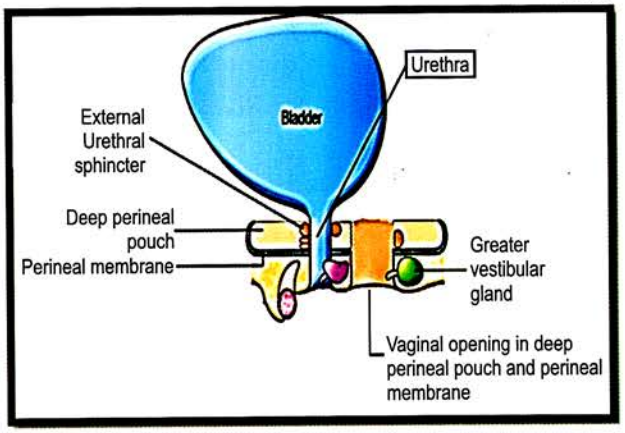
One fossa communicates with other fossa, u/l abscess becomes b/l abscess by passing behind anal canal in **horse shoe fashion.**

Sagital sec of female pelvis



Peritoneum comes out from ant. abdominal wall and covers urinary bladder,uterus,rectum and continues on posterior abdominal wall and gives broad ligament around uterus (poor supporter of uterus)
Recto-uterine pouch of douglas present between uterus and rectum

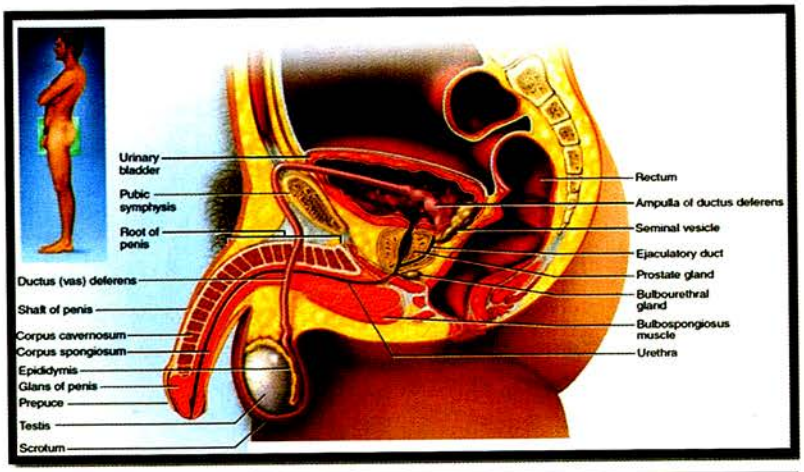
Deep perineal pouch
-Perineal membrane
floor of deep perineal pouch
->roof of superficial perineal pouch
pierced by urethra and vagina to enter into superficial perineal pouch.
-Contains ext.urethra vaginal sphincter



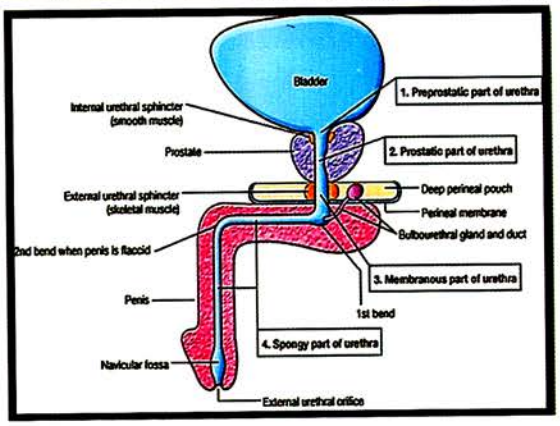
Great vestibular gland of bartholin
more posteriorly
present at the junction of middle 1/3 and post 1/3 of labia majora. Superficial transverse perineal muscle present in superficial perineal pouch. Deep Transverse perineal musclepresent in deep perineal pouch.

Saggital section of male pelvis
Prostatic urethra (4cm)
Membranous Urethra (1-2/2.5 cm)
Spongy urethra

Membranous urethra punctures
Perineal membrane become bulbous spongy urethra



Cowper/bulbourethra
Present in deep perineal pouch,duct punctures perinal membrane and enters sup.perineal pouch and opens into bulbous spongy urethra.



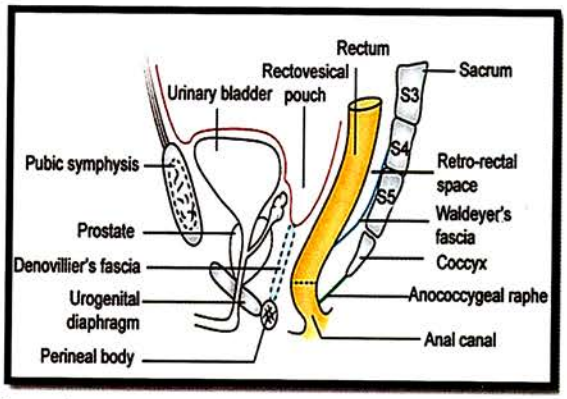
Testis produces sperms sperms carried by ductus deferens ductus deferens passes superficial inguinal ring,inguinal canal,deep inguinal **ring and become common ejaculatory duct** (puts the sperm into prostatic urethra) sperms then comes out side through penile urethra.

Bulbous spongy urethra courses through the bulb of the penis and develops endodermal outgrowths into the surrounding mesoderm to form the bulbourethral glands of Cowper. The glands are present in males in relation with membranous urethra (in the deep perineal pouch), whereas the duct opens into the bulbous spongy urethra (in superficial perineal pouch).

Penile spongy (cavernous) urethra courses through and is surrounded by the corpus spongiosum. Distal part of the penile urethra courses through the glans penis and terminates as the navicular fossa at the external urethral orifice.

Prostatic urethra and the membranous urethra together are considered as the **posterior urethra** and bulbous urethra plus the penile urethra are called the **anterior urethra**. The narrowest lumen is present at the external urethral meatus and the second narrowest is in the membranous urethra.

The widest lumen is present in the bulbous part of penile urethra, second widest is the prostatic urethra.



Recto-vesical pouch

Is a peritoneal recess between the bladder and the rectum in males, and the vesicouterine pouch is a peritoneal sac between the bladder and the uterus in females

Waldeyer's fascia (*The fascia of Waldeyer is a connective tissue by which rectum (ampulla) is attached to the sacrum and coccyx. It is the presacral fascia present between rectum and sacrum.

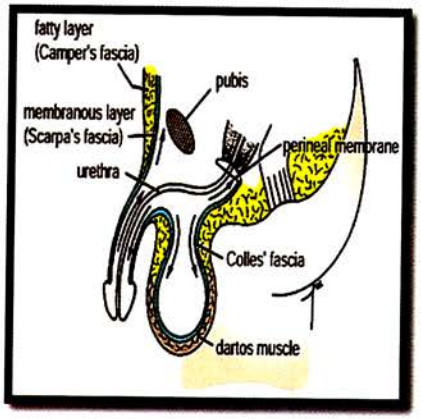
It lines the anterior aspect of the sacrum, enclosing the sacral vessels and nerves.

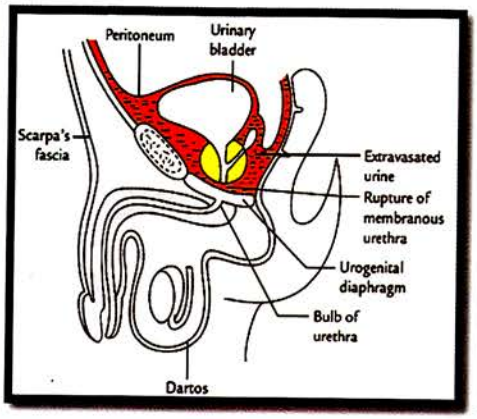
It continues anteriorly as the pelvic parietal fascia, covering the entire pelvic cavity.- It is limited postero-inferiorly, as it fuses with the mesorectal fascia, lying above the levator ani muscle, at the level of the anorectal junction.

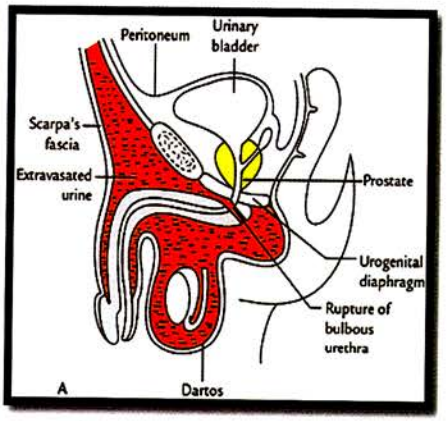
The attachments of Scarpas and Colles fasciae are such that they prevent the passage of extravasated urine due to urethral rupture backward into the ischio rectal fossae and downward into the thighs. The line of fusion of Scarpa's fascia passes over Holden's line, body of pubis, margins of pubic arch, and posterior border of the perineal membrane/posterior edge of the urogenital diaphragm.

Therefore, if male urethra is ruptured in the perineum, the extravasated urine collects first in the superficial pouch of perineum and then on to the anterior abdominal wall inferior to the umbilicus in the superficial inguinal space.

In a case of **fundal rupture of urinary bladder** (as may occur in bomb explosions), the peritoneum covering the fundus is also ruptured, leading to extravasation of urine into the peritoneal cavity (**ascites**).



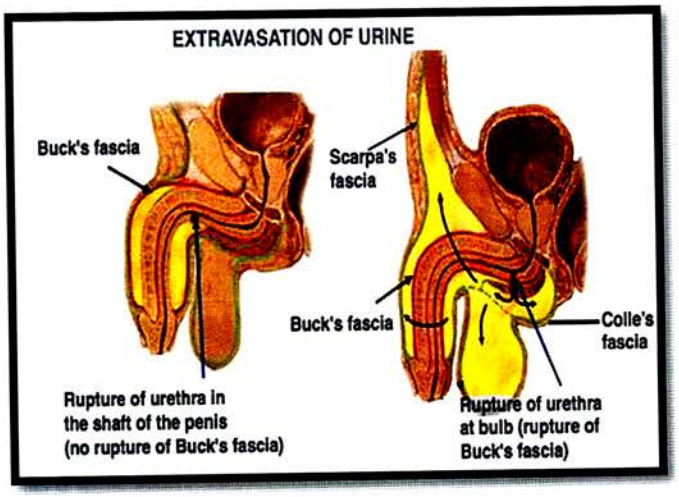


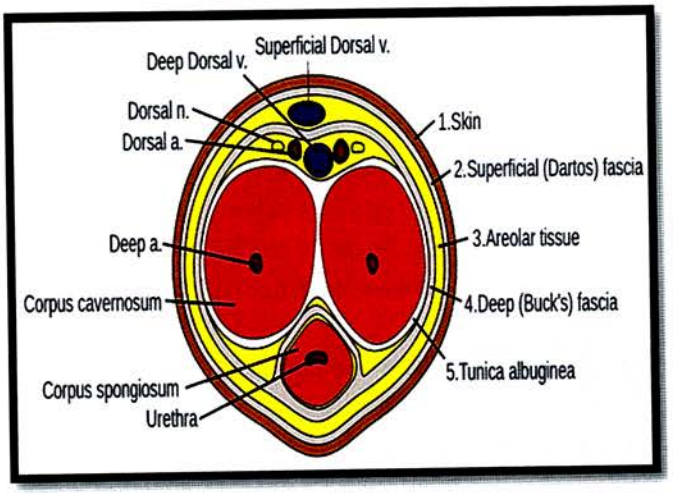


Pelvic fractures may result in pulling of pubo-prostatic ligaments and rupture of the **membranous part of the urethra**. In this case urine escapes into the deep perineal pouch and can extravasate upward into the peri-vesical space (around the prostate and bladder) or downward into the superficial perineal space (if there is associated rupture of perineal membrane).

In a case of straddle injury, there is rupture of the **bulbous portion of the spongy urethra** below the urogenital diaphragm and the extravasated urine may pass into the **superficial perineal space** and spread inferiorly into the **scrotum**, anteriorly around the **penis**, and superiorly into the lower part of the **abdominal wall**. The urine cannot spread laterally into the thigh because the inferior fascia of the urogenital diaphragm (the perineal membrane) and the superficial fascia of the perineum are firmly attached to the ischiopubic rami and are connected with the deep fascia of the thigh (fascia lata).

It cannot spread posteriorly into the anal region (ischiorectal fossa) because the perineal membrane and Colles fascia are continuous with each other around the superficial transverse perineal muscles.





It cannot enter the deep perineal pouch, because perineal membrane prevents that.

Penile fracture: Diagnosis of albugineal rupture is usually made from a characteristic history of severe pain with a cracking or popping sound during acute bending of the erect penis, followed by immediate detumescence, penile swelling, and deformity.

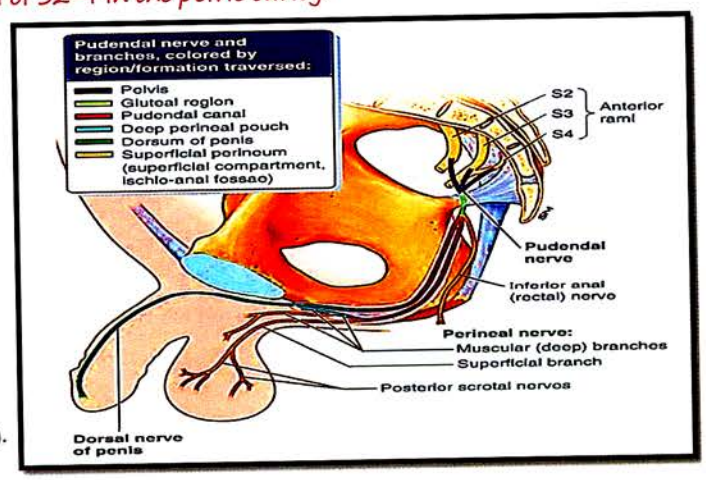
Albugineal rupture is associated with urethral injury in 10–20% of cases.

Penile hematoma is confined to the shaft when the Buck's fascia is intact. If the Buck fascia has been violated, the swelling and ecchymosis are contained within the Colles fascia. In this instance, a "butterfly-pattern" ecchymosis may be observed over the perineum, scrotum, and lower abdominal wall.

Pudendal nerve is formed by the anterior primary rami of S2–4 in the pelvic cavity.

It leaves the pelvic cavity by passing through the greater sciatic foramen (between the piriformis and coccygeus muscles). It crosses the ischial spine posteriorly and enters the perineum with the internal pudendal artery through the lesser sciatic foramen.

Next it enters the pudendal canal, gives rise to the inferior rectal nerve and the perineal nerve, and terminates as the dorsal nerve of the penis (or clitoris).



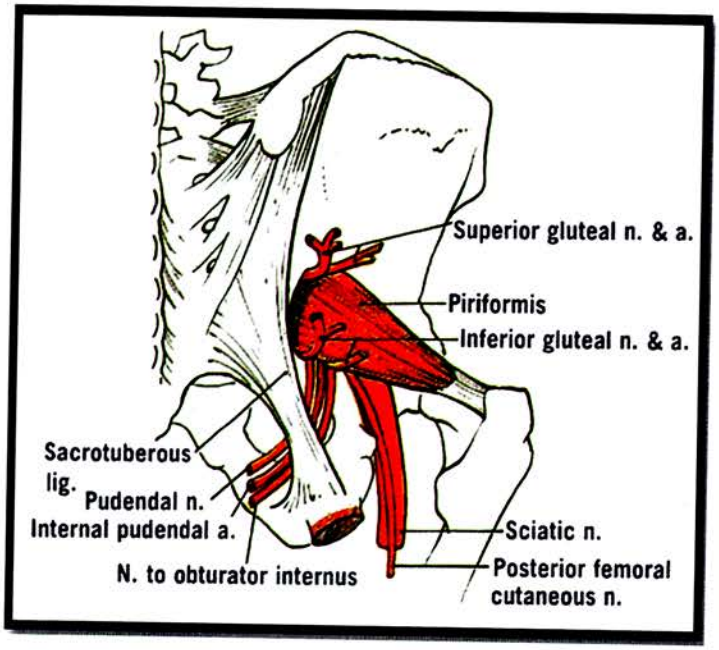
Inferior rectal nerve is a branch of pudendal nerve, given within the pudendal canal, divides into several branches, crosses the ischiorectal fossa, and innervates the sphincter ani externus and the skin around the anus. Perineal nerve divides into a deep branch, which supplies all of the perineal muscles, and a superficial (posterior scrotal or labial) branch, which supplies the scrotum or labia majora.

Dorsal Nerve of the penis (or clitoris) is the terminal branch, pierces the perineal membrane, runs between the two layers of the suspensory ligament of the penis (or clitoris), and runs deep to the deep fascia on the dorsum of the penis (or clitoris) to innervate the skin, prepuce, and glans. Alcock's pudendal canal is present in the lateral wall of ischiorectal fossa, within layers of obturator fascia. It has a length of 2.5 cm and lies above the ischial tuberosity. It extends from the lesser sciatic foramen to the posterior limit of the deep perineal pouch.

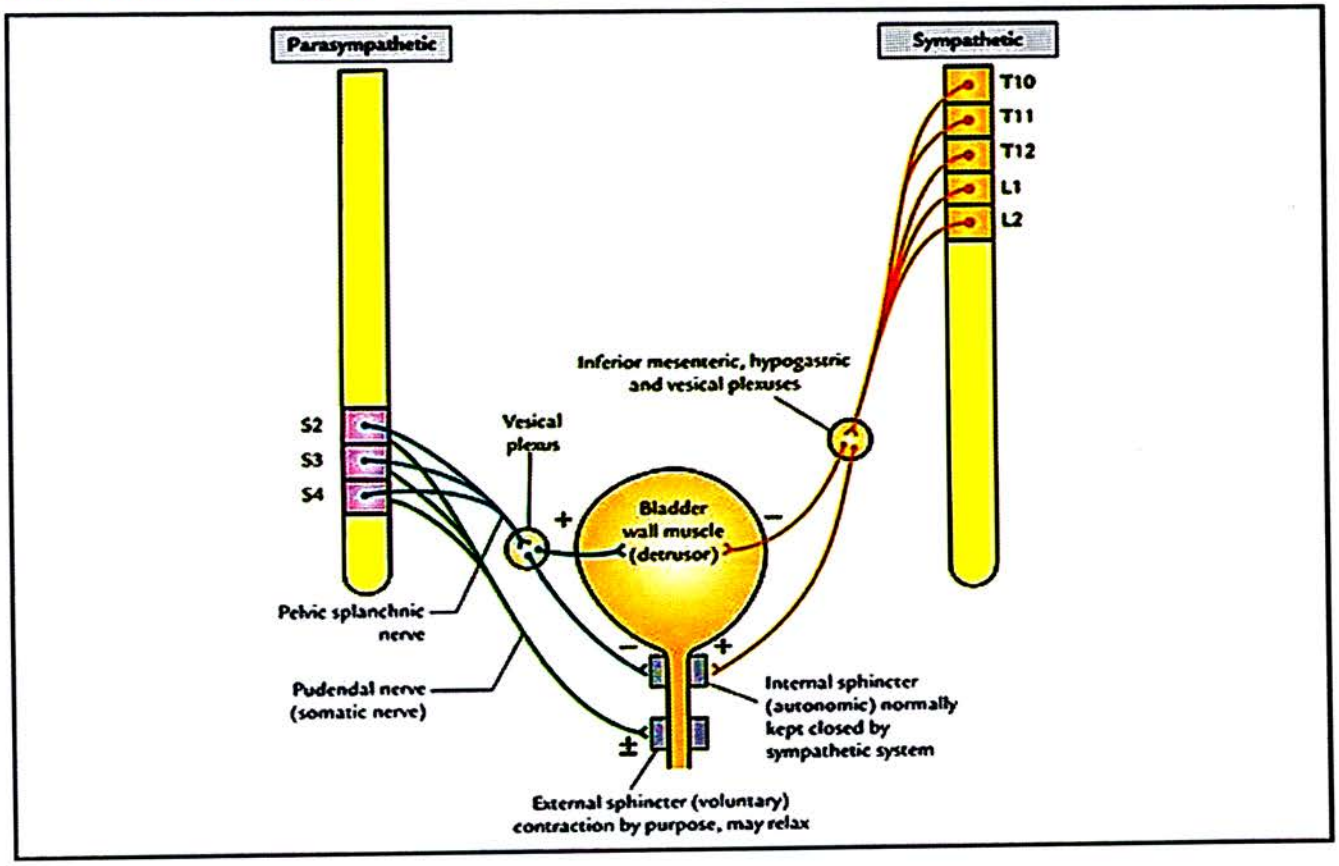
It contains pudendal nerve, internal pudendal artery and vein and send inferior rectal nerve and vessels medially through the fossa towards the anal canal. **Pudendal nerve block**: Local anaesthetic agent is injected near the pudendal nerve in the region of ischial spine. Ischial spine is the landmark and is palpated through the vagina. A needle is guided by the finger to the ischial spine. A 1% lignocaine solution is injected transvaginally or just lateral to the labia majora around the tip of the ischial spine and through the sacrospinous ligament.

Pudendal block paralyses the skeletal muscles of perineum and anaesthetizes the skin of perineum. It also leads to loss of sensation at the openings of urethra, vagina and anal canal. Pudendal block leads to urinary and faecal incontinence, hence urine and faecal matter needs to be evacuated prior to the procedure (Rectal enema and Foley's catheterization). For a complete anesthesia of the perineal region, the ilioinguinal nerve (which branches into the anterior labial nerves), genitofemoral nerve, and perineal branch of the posterior femoral cutaneous nerve are also anesthetized.

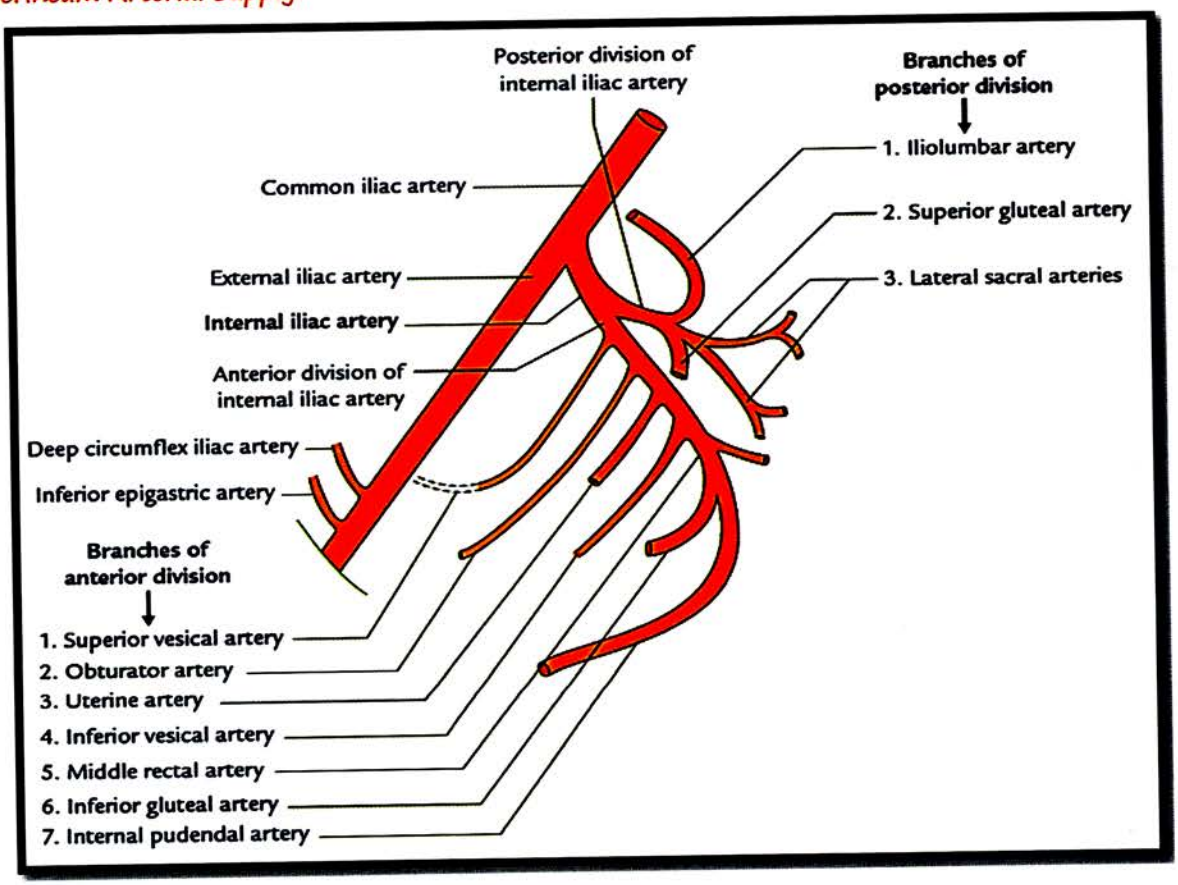
Greater sciatic foramen is bounded anterosuperiorly by the greater sciatic notch, posteriorly by the sacrotuberous ligament and inferiorly by the sacrospinous ligament and ischial spine.
Piriformis muscle pass through it, above which the superior gluteal vessels and nerve leave the pelvis. Below piriformis, the inferior gluteal vessels and nerve, sciatic and posterior femoral cutaneous nerves, nerve to quadratus femoris and **PIN structures** (Pudendal nerve, Internal pudendal vessels and Nerve to obturator internus) leave the pelvis.
Other important structures as they exit the pelvic cavity to enter the gluteal and thigh regions: Superior gluteal vein, artery, and nerve; inferior gluteal vein, artery, and nerve; sciatic nerve..



Pelvis Perineum Nerve Supply:



Pelvis Perineum Arterial Supply:



Supports of uterus:

Supports of uterus

Muscular (dynamic supports) - provide excellent support

Pelvic diaphragm (levator ani and coccygeus)

Urogenital diaphragm (urethral sphincter & deep transverse perinei)

Perineal body (common perineal tendon for attachment of numerous perineal muscles)

Pelvic fascia condensations (passive supports) - provide good support

Transverse cervical ligaments (of Mackenrodt).

Pubo-cervical ligaments.

Uterosacral (sacro-cervical) ligaments

Peritoneal folds - provide poor support

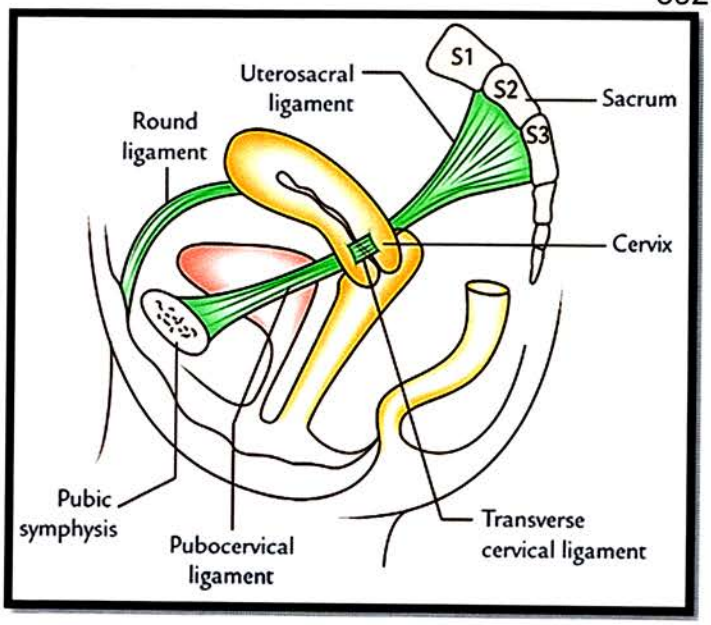
Broad ligaments

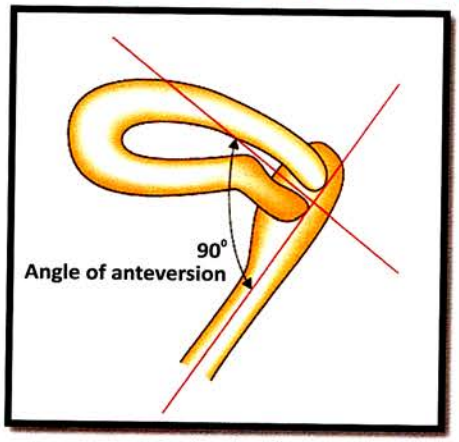
Round ligament of uterus (remnant of the gubernaculum in the embryo)

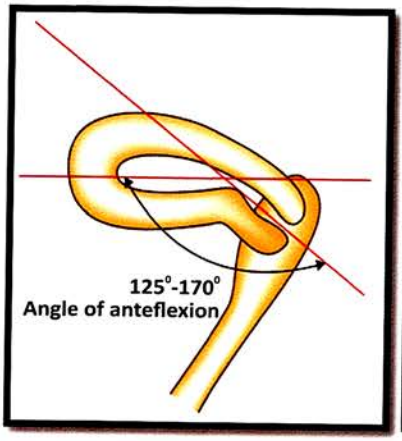
Utero-vesical fold of peritoneum

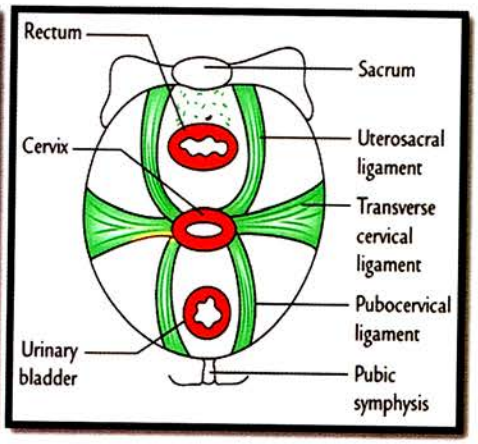
Recto-vaginal fold of peritoneum

Uterine position and axis (ante-flexed and ante-verted)







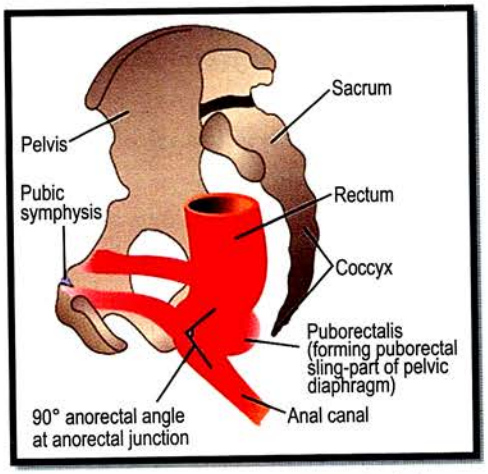


Transverse Cervical Ligaments of Mackenrodts are the most important ligaments of the uterus, hence often called cardinal ligaments. They are the fibromuscular condensation of pelvic fascia around the uterine vessels, at the base of broad ligament. They are fan-shaped fibromuscular bands extending from the lateral aspect of cervix and upper vaginal wall to the lateral pelvic wall. They form a hammock which supports the uterus and prevent its downward displacement.

Pubocervical Ligaments are a pair of fibrous bands which extend from the cervix to the posterior aspects of the pubic bones. **Uterosacral Ligaments** are a pair of fibrous bands which extend from the cervix to the second and third sacral vertebrae, and pass on each side of the rectum. These ligaments pull the cervix backward against the forward pull of the round ligaments and help in the maintenance of anteflexed and anteverted positions of the uterus. **Round Ligaments** of the Uterus are a pair of fibromuscular bands which lie between the two layers of broad ligament. It begins at the lateral angle of the uterus, passes forward and laterally between the two layers of broad ligament, enters the deep inguinal ring after winding around the lateral side of the inferior epigastric artery.

It traverses the inguinal canal, emerges through the superficial inguinal ring, and splits into numerous thread-like fibrous bands which merge with the fibroareolar tissue of the **labium major**. These ligaments pull the fundus forward and help to maintain the anteversion and anteflexion of the uterus. **Sacro-cervical** ligaments extend from the lower end of the sacrum to the cervix and the upper end of the vagina. **Rectouterine** (Sacro-uterine) Ligaments hold the cervix back and upward and sometimes elevate a shelf-like fold of peritoneum (rectouterine fold), which passes from the isthmus of the uterus to the posterior wall of the pelvis lateral to the rectum. It corresponds to the sacro-genital (recto-prostatic) fold in the male.

Prolapse of uterus may occur if the supports are weakened. During parturition the muscular supports undergo lot of stretching and may give up, leading to uterus being pushed inside vagina and come out into the perineum.
Surgical support: The cardinal ligaments have enough fibrous content to provide anchor for the wide loops of sutures during several surgical procedures.



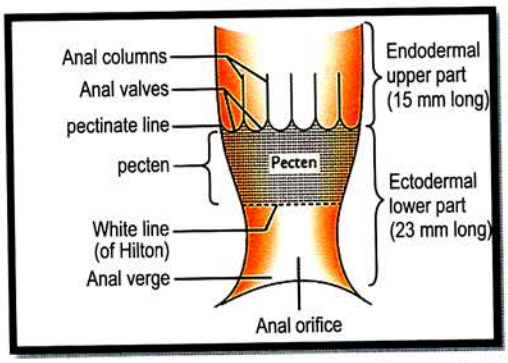
Anorectal ring (or flexure) is the demarcation between the rectum and the anal canal, where the puborectalis muscle forms a sling around the posterior aspect of the anorectal junction, kinking it anteriorly.

It is formed by fusion of fibres of:
- Puborectalis
- Uppermost fibres of external anal sphincter
- Internal anal sphincter

Anorectal Angle

Faecal continence is maintained by normal rectal sensation and tonic contraction of the internal anal sphincter and the puborectalis muscle, which wraps around the anorectum, maintaining an anorectal angle between 80° and 110°. The angle is 2–3 cm anterior to and slightly below the tip of the coccyx, level with the apex of the prostate in males.

Damage to the anorectal ring results in rectal incontinence. Defecation is initiated by distention of the rectum, the afferent impulses carried by the pelvic splanchnic nerves.



Anal Canal:

Anal canal is the terminal portion of the large intestine having a length of ~ 4 cm long and extends from the rectum at the anorectal junction to the surface of the body at the anus.

It divides into an upper two-thirds (visceral portion), which belongs to the intestine, and a lower one-third (somatic portion), which belongs to the perineum.

A point of demarcation between visceral and somatic portions is called the pectinate (dentate) line, which is a serrated line following the anal valves.

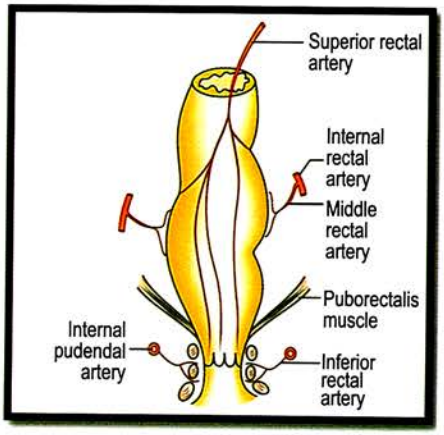
Upper Anal Canal

It is lined by **simple columnar epithelium**.

Lower Anal Canal

It is lined by **stratified squamous epithelium** (non-keratinized) till Hiltons line. Below that it becomes keratinized.

Hilton white line is the intermuscular (inter-sphincteric) groove between the lower border of the internal anal sphincter and the subcutaneous part of the external anal sphincter. It indicates the junction between keratinized stratified squamous epithelium and non-keratinized stratified squamous epithelium.



Arterial supply

Rectum

Superior rectal artery (continuation of the inferior mesentery artery) is the chief supply.
Middle rectal artery (branch of anterior division of the internal iliac artery).
Inferior rectal artery (branch of internal pudendal artery)
Median sacral artery (branch of the abdominal aorta)

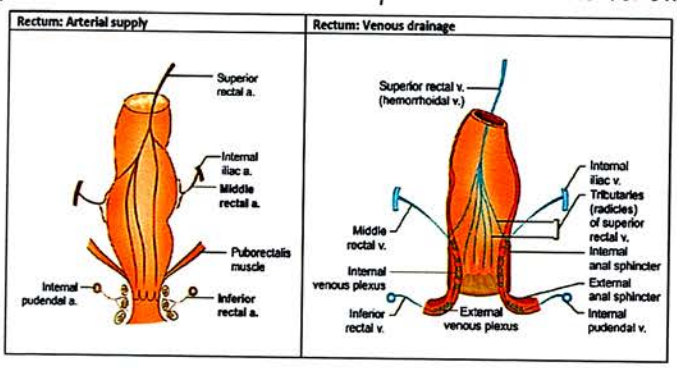
Anal canal

It is supplied by terminal branches of the **superior rectal artery** and the **inferior rectal artery**, together with a small contribution from the **median sacral artery**.
Middle rectal artery do not supply the anal canal.

Venous drainage

Venous drainage of the rectum and anal canal parallels the arterial supply.

Upper portions are drained predominantly by the superior rectal veins, tributaries portal mesenteric venous system;
some blood returns to the systemic circulation via the middle rectal veins.
→ Superior rectal vein → inferior mesenteric vein → portal vein → hepatic sinusoids → central veins → hepatic veins → inferior vena cava



→ Middle rectal vein → internal iliac vein → common iliac vein → inferior vena cava

Lower portions drain via the inferior rectal branches of the internal pudendal vein into systemic circulation.
→ Inferior rectal vein → internal pudendal vein → internal iliac vein → common iliac vein → inferior vena cava
Porto-systemic anastomosis: Superior rectal vein (tributary of portal vein) forms anastomosis with middle and inferiorrectal veins (tributaries of inferior vena cava).

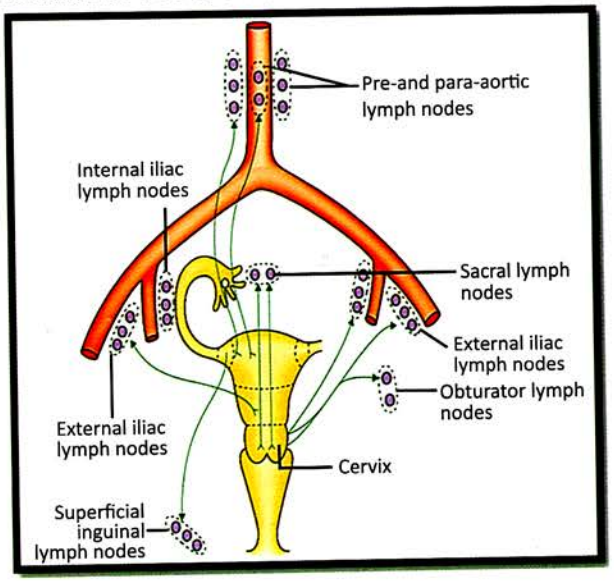
Internal hemorrhoids are varicosities of the superior rectal veins. They are located above the pectinate line and are covered by rectal mucosa. These present with painless bleeding.
External hemorrhoids are varicosities of the inferior rectal veins. They are located below the pectinate line near the anal verge and are covered by skin. These present with painful bleeding.

Lymphatic Drainage

Rectum

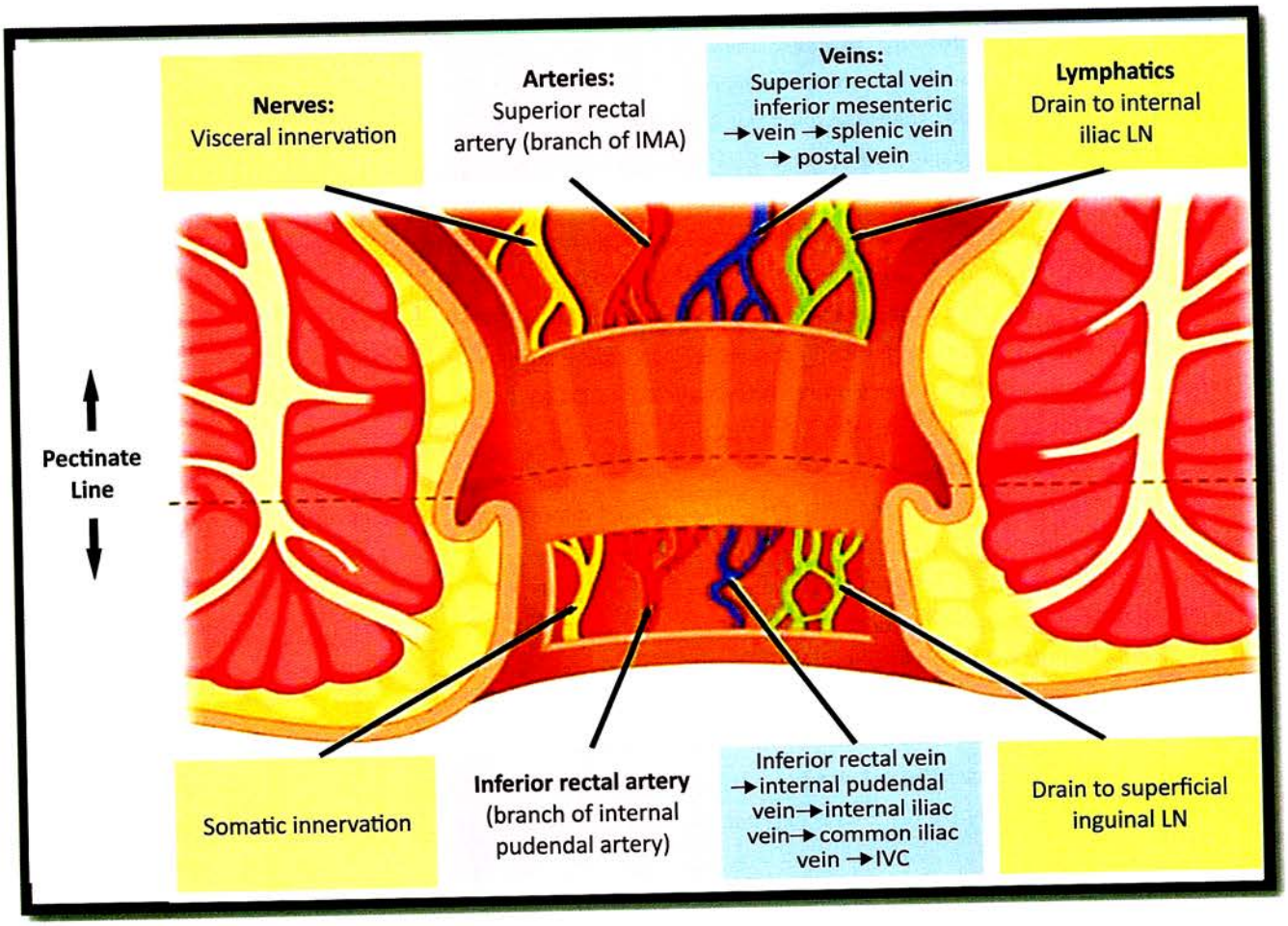
Upper half lymphatics accompany the superior rectal vessels and drain into the inferior mesenteric nodes.
- Few of these vessels drain into the pararectal lymph nodes (on each side of the rectosigmoid junction).

Lower half lymphatics accompany the middle rectal vessels and drain into the internal iliac nodes.



Anal canal

Pectinate line forms the "water shed line" of the anal canal.
- **Upper** half lymphatics drain into the **internal iliac lymph nodes**
- **Lower** half lymphatics drain into the **superficial inguinal** lymph nodes (horizontal group)



- Trochanter of femur is an example of traction epiphysis (NEET Pattern 2012)
- Mastoid process is traction epiphysis (NEET Pattern 2015)
- Mandible is not a pneumatic bone (AIPG 2011)
- Metaphysis is the epiphyseal end of the diaphysis.
- Parietal bone is not a pneumatic bone (AIIMS 2003)
- Pisiform is a sesamoid bone (NEET Pattern 2015)
- Innervated structures of Joints are Synovium, Capsule and Ligaments (NEET Pattern 2013)
  - Articular cartilage has no neurovascular bundle.
- Hilton's law is related to Nerve Innervation (NEET Pattern 2016)
- Knee is a diarthrosis type of Joint.
- Joint between epiphysis and diaphysis of a long bone is a type of Synchondrosis (AIIMS 2004)
- Ear ossicles articulate with each other through Synovial type of Joints (NEET Pattern 2012)
  - Malleus-incus Joint is a saddle synovial joint and Incus -stapes is ball and socket synovial Joint.
- Intracapsular articular disc is present in Sternoclavicular Joint (NEET Pattern 2012)
- Vomerine ala and sphenoidal rostrum Junction is a Schindylesis (NEET Pattern 2013)
- Pubic symphysis is a Cartilaginous type of Joint (NEET Pattern 2015)
- Inferior tibia-fibular Joint is a Syndesmosis.
- Midline intervertebral Joint with intervertebral disc is Secondary cartilaginous (NEET Pattern 2016)
- The type of Joint between the sacrum and the coccyx Is a Symphysis (AIPG 2005)
- Atlantoaxial Joint is a Pivot synovial Joint (NEET Pattern 2015, 16)
- Smallest muscle in the body is Stapedius (NEET Pattern 2015)
  - The smallest skeletal muscle in the body is stapedius.
  - The smallest muscle in the body is arrector pilorum, a smooth muscle in the skin for erection of hair.
- Longest muscle in the body is Sartorius (NEET Pattern 2012)
- Flexor digitorum superficialis does not have dual nerve supply (NEET Pattern 2012)
- Most common muscle to be congenitally absent Is Pectoralis major (AIPG 2009)
- Popliteus muscle has an Intra-articular tendon (JIPMER 2016)
- Rectus femoris is not a hybrid muscle (AIPG 2008)
- Flexor carpi ulnaris is not a hybrid muscle.
- All the muscles of body develop from mesenchyme except arrector pill, muscles of iris and myoepithelial cells, which develop from ectoderm.
- Largest muscle in the body is gluteus maximus.
- Functional unit of a muscle is sarcomere.
- Most variable muscle in the body is palmaris longus.
- Longest tendon in the body is plantaris in the leg.
- Largest tendon in the body is tendo calcaneus (Achilles tendon).
- Most commonly used muscle for Intramuscular injection is deltoid.
- Muscles with smallest motor unit are extraocular muscles and largest are lower limb muscles like gluteus maximus.
- Talus bone in the foot and Incus bone in the middle ear cavity have no muscle attachments.
- 2nd arch artery does NOT take part in formation of right subclavian artery (NEET Pattern 2015)
- Artery of 2nd pharyngeal arch is stapedial artery (NEET Pattern 2012)
- Artery of 3rd arch is common carotid artery (NEET Pattern 2015)

- Right fourth arch artery gives rise to right subclavian artery (NEET Pattern 2014)
- External carotid artery arises as a sprout from the common carotid artery.
- 6th aortic arch forms ductus arteriosus (JIPMER 2017)
  - Proximal part of 6th aortic arch forms pulmonary arteries on both sides.
  - The distal portion of 6th arch forms ductus arteriosus, which later Regresses on Right (RR) and Left is Left (LL).

General Embryology

- Meiosis occurs in Seminiferous tubules (AIIMS 2004)
  - Sperms reach epididymis where they mature, gain progressive motility and are stored until ejaculation.
- Spermatogenesis begins at Puberty (NEET Pattern 2016)
  - Primordial germ cells remain dormant until puberty.
- Development of spermatozoa (sperm) from spermatogonium takes 70-75 days (NEET Pattern 2014)
- Spermatogenesis occurs at temperature lower than core body temperature (AIPG 2008)
- Meiosis occurs at transformation of primary spermatocyte to secondary spermatocyte (AIIMS 2007)
- Primary spermatocytes are diploid (2n) cells containing 46 chromosomes (46-XY) (NEET Pattern 2014)
- Polar bodies are formed during Oogenesis (AIPG 2006)
- First polar body is formed after First meiosis (NEET Pattern 2014)
  - Primary oocyte completes meiosis Ito form two daughter calls: the secondary oocyte (23, 2N) and the first polar body.
- Diplotene and zygotene stages are seen In Prophase (NEET Pattern 2015)
  - Prophase I (of meiosis I) is divided into 4 stages: Leptotene, Zygotene, Pachytene and Diplotene, followed by Diakinesis.
- At birth the ovary contains primary oocyte in Prophase-I of meiosis (AIMS 2015)
- In the ovaries, primary oocytes reach diplotene stage of prophase I (meiosis I), by the fifth month in utero and each remains at this stage until the period before ovulation (may be as long as up to 50 years).
- After first meiotic division, the primary oocyte remains arrested in Diplotene stage (NEETPattern 2012)
  - Primary oocytes enter prophase I (of meiosis I) and remains arrested in prophase (diplotene) of meiosis I until exposed to LH surge, which starts happening after puberty.
- One primary oocyte forms one ovum (NEET Pattern 2013)
- Abnormal persistence of Primordial germ cells in primitive streak result in sacrococcygeal teratoma.
  - Teratomas may arise from PGCs (or from epiblast cells), both being pluripotent cells.
  - Therefore, within teratomas are present derivatives of all three germ layers and may include skin, bone, teeth, gut tissue.
- Remnant of notochord is Nucleus pulposus (NEET Pattern 2013)
- Somites develop from paraxial mesoderm (NEET Pattern 2014)
- Pupillary muscles do not develop from mesoderm (AIMS 2014)
- Development of peritoneal cavity is from Intraembryonic coelom (NEET Pattern 2012)
  - Intraembryonic coelom forms the cavities like pericardial, pleural and peritoneal cavities.
- Pericardial cavity is an intraembryonic coelomic cavity (NEET Pattern 2014)
- First pair of somites arises in the occipital/cervical region of the embryo at approximately the 20th day of development (NEET Pattern 2014)
- Mesoderm refers to cells derived from the epiblast and extraembryonic tissues.

- Mesenchyme refers to loosely organized embryonic connective tissue regardless of origin.
- Sclerotome forms the vertebrae and the ribs and part of the occipital bone
- Myotome forms the musculature of the back, the ribs and the limbs
- Syndetome forms the tendons and the dermatome forms the skin dermis on the back.
- Majority of the skeletal muscle in the body develops from paraxial mesenchyme and its segmental derivatives, the somites.
- Smooth muscles develop from the splanchnopleuric mesenchyme in the walls of the viscera and around the endothelium of blood vessels.
- Yolk sac is derived from Hypoblast (NEET Pattern 2016)
- Fetoplacental circulation is established at day 17-22 (week 3), post fertilization.
- Tertiary villi develop by the end of week 3 (day 17-21).
- Two umbilical arteries are normally joined at the chorionic plate, by transverse anastomosis called Hyrtl's anastomosis (NEET Pattern 2015)
- Wharton Jelly is the connective tissue of the cord (NEET Pattern 2018)
- Septum transversum develops from mesoderm (NEET Pattern 2016)
  - Septum transversum is a plate of cranial mesoderm, descending down to reach the Junction of thorax and abdomen and contributing to central tendon of diaphragm.
- Diaphragm does not develop from pleuropericardial membrane (AIIMS 2015)
- Diaphragm doesn't develop form dorsal mesocardium (AIPG 2011, NEET Pattern 2016)
- Crus of diaphragm develops from dorsal mesentery of esophagus (NEET Pattern 2016)
- Myoblasts of diaphragm develops from cervical 3-5 somites (NEET Pattern 2012)
- Kidney doesn't develop in mesentery of stomach (AIIMS 2010)
  - It Lies on the posterior abdominal wall and develops behind peritoneum (is retroperitoneal).
- Ascending colon has no mesentery (NEET Pattern 2015)
- Gastrosplenic ligament contains short gastric artery (NEET Pattern 2015)
- Splenic artery is carried by splenorenal ligament (NEET Pattern 2014)
- Spleen develops from cephalic part of dorsal mesogastrium (NEET Pattern 2015)
- During development spleen lobulation is related to superior border (NEET Pattern 2015)
- Greater omentum develops from dorsal mesentery (NEET Pattern 2018)
- Mockers diverticulum is a remnant of vitellointestinal duct (AIMS 2005; NEET Pattern 2013)
- Mesenteric cyst is NOT an anomaly of Vitello-intestinal duct.
- Proximal half of duodenum is derived from fore gut and distal half from the midgut (NEET Pattern 2013)
- Descending colon is supplied by inferior mesenteric artery (JIPMER 2016)
- Vermiform appendix is a derivative of midgut (NEET Pattern 2015)
- Primitive gut develops from the endoderm of yolk sac (NEET Pattern 2014)
- Inferior mesenteric artery supplies the derivatives of the hind gut (NEET Pattern 2013)
- Ureter develops from mesonephric duct (AIMS 2007; NEET Pattern 2018)
- Most common aberration in renal vessel development is supernumerary arteries (AIPG 2010)
- Urinary bladder, liver, pancreas are endodermal derivatives, but kidney is mesodermal (JIPMER 2006)
- Urinary bladder develops from endoderm (NEET Pattern 2012)
  - It develops from the cranial vesicourethral canal, which is continuous above with the allantoic duct.
- Ureteric bud arises from Mesonephric duct (NEET Pattern 2013)
  - Hence called mesonephric diverticulum.
  - As it stimulates metanephros, it is also known as the meta nephrogenic diverticulum.

- Ascending kidney receives its blood supply sequentially from arteries in its immediate neighbourhood, i.e. the middle sacral and common Iliac arteries.
- Epithelium of urinary bladder, urethra and vagina develop from endoderm of Urogenital sinus.
- Ascent of horseshoe-shaped kidney is prevented by inferior mesenteric artery (NEET Pattern 2016)
- Collecting tubules of kidney develop from Ureteric duct/bud (NEET Pattern 2013)
- Proximal convoluted tubules develop from Metanephric tubules.
- Uro-rectal septum separates the cloaca into rectum and urogenital sinus.
- Urachus fistula is patent allantois (PGIC 2004)
- Total number of oocytes at birth are 1-2 million (NEET Pattern 2013)
- Upper 3/4th of vagina develops from Mullerian duct (NEET Pattern 2012)
- Vaginal wall is derived from endoderm and mesoderm (NEET Pattern 2013)
- Ovary Is present in Mullerian duct anomaly (AIPG 2008)
- Organ of Rosenmuller (epoophoron/parovarium) is a remnant of the mesonephric tubules (NEET Pattern 2012)
  - It can be found next to the ovary and fallopian tube.
- Gartner's duct: The paravaginal duct; a mesonephric duct remnant. Gartner's cyst is the vaginal remnant of Gartner's duct, usually a benign cyst in the anterolateral wall of vagina.
- Round ligament of uterus are derivatives of Gubernaculum (NEET Pattern 2014)
- Prostate analogue in female is Skene gland (NEET Pattern 2016)
- Differentiation of genital ridge takes place at 2 months (NEET Pattern 2013)
- Male and female differentiation of fetus occurs at 7th week (NEET Pattern 2016)
- Y chromosome is a short acro-centric without the satellite (NEET Pattern 2012)
- Gubernaculum is attached to caudal pole of testis.
- Appendix of testis is derived from cranial end of paramesonephric duct (NEET Pattern 2015)

Histology

- Mesothelium of serous cavities (pleura, pericardium and peritoneum) is lined by simple squamous epithelium.
- Thyroid follicles are lined by cuboidal epithelium (NEET Pattern 2013)
  - Actively secreting thyroid follicles are lined by simple columnar epithelium.
  - Resting follicles are lined by simple squamous epithelium.
- Cells in transitional epithelium are provided with extra reserve of cell membrane (AIPG 2003)
  - Gets used up while stretching, helps in increased storage.
- Cornea is lined by squamous non-keratinized epithelium (NEET Pattern 2012)
- Lining epithelium of ventricles of brain is columnar epithelium (NEET Pattern 2013)
- Ventricles of brain and central canal of spinal cord are lined by ciliated simple columnar epithelium with microvilli.
- Gallbladder is lined by columnar cells with irregular microvilli - brush border (AIIMS 2007)
- Small intestine is lined by microvilli arranged in regular fashion—striated border.
- Brush border is also present in the proximal convoluted tubule (PCT) of kidney.
- Stereocilia are present in the hair cells of Internal ear and epididymis.
- Ceruminous glands present in the ear are modified apocrine glands. (AIIMS 2005)
- Vagina has no glands are seen in the mucosa, its surface receives the secretions of glands in the cervix.
- Mammary gland Is a type of modified sweat gland. (NEET Pattern 2015)
- In hyaline cartilage, type of collagen present is type II. (AIIMS 2007)

- Basement membrane has type IV collagen fibers. (AIIMS 2015, 17)
- The papillary region of dermis is composed of loose areolar connective tissue.
- The reticular dermis found under the papillary dermis is composed of dense Irregular connective tissue featuring densely packed collagen fibers.
- Muscle Is NOT a connective tissue. (NEET Pattern 2012)
- Temporomandibular joint has fibrocartilage (not hyaline). (NEET Pattern 2012)
  - Usually synovial joints have hyaline cartilage.
- Meniscus Is NOT a hyaline cartilage. (NEET Pattern 2012)
- Elastic cartilage is seen in epiglottis. (NEET Pattern 2012)
- Haversian system is found in diaphysis of long bones. (AIPG 2000)
- Subcapsular sinuses are seen in the lymph node. (NEET Pattern 2012)
- Cords of Billroth are present in the red pulp of the spleen. (NEET Pattern 2013)
- Stave cells are seen in the spleen. (NEET Pattern 2012)
- Clara cells are dome-shaped cells with short microvilli, found in the terminal bronchioles and extend into respiratory bronchioles as well in (NEET Pattern2012)
- Esophagus does not have serosa (NEET Pattern 2016)
- Barrett's esophagus is diagnosed by Intestinal metaplasia (AIIMS)
- Hepatic vein NOT the component of portal triad in liver (NEET Pattern 2015)
- Stellate cells of von Kupffer are seen in the sinusoids of liver.
- Stellate cells of Ito are present in liver (NEET Pattern 2016)
  - These are also called hepatic stellate cells and are present in liver for storage of fat or fat-soluble vitamins including vitamin A.
- Space of Disse is seen in liver (NEET Pattern 2012, 14)
- Blood testis barrier Lies between Sertoli - Sertoli cells.
- Acrosome cap of sperm is derived from Golgi body (NEET Pattern 2014)
- Middle piece of sperm contains mitochondria (NEET Pattern 2015)
- Corpora amylacea is seen in prostate (NEET Pattern 2012)
- Epithelium of ovarian follicle is stratified cuboidal while that of ovary Is simple cuboidal.
- Corpora arenacea (or brain sand) are calcified structures in the pineal gland which become increasingly visible on X-rays over time (NEET Pattern 2012)

Abdomen

- Supracristal plane passes through the lower part of the body of L4 vertebra (NEET Pattern 2016)
- Supracristal plane is above highest point of iliac crest
- Renal angle Lies between 12th rib and lateral border of sacrospinalis (erector spinae) (AIIMS 2007; NEET Pattern 2012)
- Highest point of Iliac crest Lies at the level of spine of L4 vertebra (NEET Pattern 2014)
- Fundus of gallbladder Is present at L1 vertebral level (NEET Pattern 2015)
- Trans tubercular plane Lies at L5 vertebral level (NEET Pattern 2013)
- Pyramidalis supplied by Subcostal nerve (NEET Pattern 2015)
- In rectus sheath superior epigastric artery (branch of internal thoracic artery) anastomose with Inferior epigastric artery (branch of external Iliac artery). (PGI 2006)
- Nerve supply to the skin around the umbilicus Is 10th thoracic ventral ramus.

- Neurovascular bundle in anterior abdominal wall lies between internal oblique and transverse abdominis (NEET Pattern 2012)
- Inferior epigastric artery is a branch of external iliac artery (NEET Pattern 2016)
- Accessory obturator artery is a branch of Inferior epigastric artery (NEET Pattern 2016)
- Usually Internal Iliac (anterior division) gives the obturator artery.
- Accessory obturator artery Is related to lacunar ligament (NEET Pattern 2016)
  - The artery should be protected in reduction of femoral hernia, while the lacunar ligament Is cut to enlarge the femoral ring.
- Common hepatic artery is a branch of celiac trunk (NEET Pattern 2016)
- Gastroduodenal artery Is derived from hepatic artery (AIIMS 2005)
- Arteria pancreatic magna is a branch of splenic artery (NEET Pattern 2015)
- Short gastric arteries are branches of splenic artery (NEET Pattern 2013)
- Posterior gastric artery Is a branch of splenic artery (JIPMER 2011; NEET Pattern 2014)
- Superior Pancreaticoduodenal artery Is a branch of gastroduodenal artery
- Left colic artery is a branch of Inferior mesenteric artery
- Appendicular artery Is a branch of Ileocolic artery
- Caudate process of liver Lies to the right side of celiac trunk
- Superior mesenteric artery does not supply stomach (NEET Pattern 2014)
- Portal vein is formed by the union of splenic and superior mesenteric veins (NEET Pattern 2013)
- Structure Immediately posterior to pancreatic head is right renal vein. (NEET Pattern 2012)
- Hepatic veins drain directly Into IVC (not into mesenteric or splenic veins)
- Portal venous system is valveless (AIIMS 2008)
- Portacaval anastomosis seen between superior rectal vein and inferior rectal vein.
- At lower end of esophagus, Porto-caval anastomosis in between tributary of left gastric vein (portal circulation) and esophageal vein (systemic circulation).
- Porto systemic shunt is NOT seen in spleen (AIPG 2007)
- Inferior epigastric vein drains into external iliac vein (NEET Pattern 2015)
- Inferior epigastric artery forms the boundary of Hesselbach's triangle (NEET Pattern 2013)
- Inguinal ligament is at the base of the femoral triangle and inferior boundary of Hesselbach's triangle (NEET Pattern 2012)
- Content of femoral canal is lymph node (NEET Pattern 2076)
- Inguinal ligament is derived from external oblique (NEET Pattern 2016)
- Internal spermatic fascia is derived from fascia transversalis (NEET Pattern 2013)
- Inguinal canal is NOT bounded posteriorly by lacunar ligament
- Lacunar ligament forms the floor of inguinal canal (and not the posterior wall).
- Femoral vein lies lateral to sheath of femoral hernia (AIIMS 2011)
- Femoral artery doesn't lie in the boundary of femoral ring (AIPG 2005)
- Femoral nerve Lies outside the femoral sheath.
- In femoral hernia, the Intestine may enter the femoral ring, and the femoral canal to reach thigh region, and lie Inferolateral to pubic tubercle.
- Inferior epigastric artery enters the rectus sheath and is a landmark to differentiate between direct and Indirect Inguinal hernia.
- Indirect Inguinal hernia: In young adults, Intestine may pass through the deep inguinal ring (lateral to Inferior epigastric artery), enter the inguinal canal and reach the scrotum.

- Direct inguinal hernia in elderly patients, intestine may pass medial to inferior epigastric artery and enter the scrotum.
- Note: Inguinal hernia (direct or indirect) lie's superomedial to pubic tubercle and enters the scrotum. Whereas, femoral hernia lies inferolateral to pubic tubercle and enters the thigh region.
- Superficial Inguinal ring is a hiatus in the aponeurosis of external oblique, Just above and lateral to the crest of the pubis.
- Deep Inguinal ring is a deficiency in transversalis fascia (AIIMS 2008)
- Right testicular vein drains into IVC (JIPMER 2016)
- Left testicular vein drains Into Left renal vein (NEET Pattern 2015)
- Most of the sperms are stored in the epididymis, although a small quantity is stored in the vas deferens
- Lymphatic drainage of testes is Paraaortic lymph nodes (NEET Pattern 2012)
- Left testis descent begins early, and it Lies slightly at the lower level than the right (Left - Lower) (NEET Pattern 2013)
- The intricately and prodigiously looped system of veins and arteries that lie on the surface of the epididymidis known as pampiniform plexus of veins (AIPG 2004)
- Capacitance of sperm takes place in isthmus of the uterine tubes.
- Sperm acquires motility in Epididymis (NEET Pattern 2014)

- Testis measure 4-5 cm in length, 2-3 cm in breadth and 3-4 cm in anteroposterior diameter; their weight varies between 12 and 20 g.
- Corpus spongiosum get terminally expanded to form glans penis.
- Penile urethra runs in corpus spongiosum.
- Anterior one third of scrotum is supplied by Ilioinguinal nerve (L1) and genital branch of the genito-femoral nerve (L1) (NEET Pattern 2016)
- Posterior two third of scrotum is supplied by posterior scrotal nerves (S3) and perineal branch of posterior cutaneous nerve of thigh (S3).
- Dartos muscle and cremasteric muscles are supplied by the genital branch of the genitofemoral nerve.
- Cremasteric artery is a branch of inferior epigastric artery (NEET Pattern 2015)
  - It accompanies the spermatic cord and anastomoses with testicular artery (Internal spermatic artery).
- Seminal colliculus is present in urethra (NEET Pattern 2016)
- Prostatic artery Is a branch of Inferior vesical artery (NEET Pattern 2015)
- Zone prone to benign prostatic hypertrophy is transitional zone.
- Benign Prostatic hypertrophy is associated with enlargement of Median lobe (AIPG 2005; NEET Pattern 2016)
- Median lobe of prostate gland raises uvula vesicae.
- Lymph from glans penis drains Into Deep Inguinal lymph nodes (NEET Pattern2012)
- Root value of cremaster reflex Is L1,L2 (AIIMS 2017)
- The most dependent part of abdomen in standing position is rectouterine pouch of Douglas. (NEET Pattern 2013)
- Rectouterine pouch of Douglas lies between rectum (posteriorly) and uterus and posterior fornix of vagina (anteriorly).
- A posteriorly perforating ulcer in the pyloric antrum of the stomach is likely to produce initial localized peritonitis or abscess formation in the lesser sac (omental bursa). (AIPG 2003, AIIMS 2004)
- Bile duct lies anterior to epiploic foramen (NEET Pattern 2014)

- Caudate (not quadrate) lobe lies as the superior border of the epiploic foramen.
- Spleen projects into the greater sac of peritoneal cavity (AIIMS 2008, 11)
- Foramen of Winslow is a communication between greater sac and lesser sac (NEET Pattern2016)
- Free edge of lesser omentum contains bile duct, hepatic artery and portal vein (JIPMER 2016)
- Common bile duct lies right to hepatic artery (JIPMER 2013)
- Morison's pouch is right subhepatic space (NEET Pattern 2015)
- Inferior mesenteric vein is found in relation to the paraduodenal fossa (AIPG 2008)
- The vessel traversing mesocolon is middle colic artery (NEET Pattern 2016)
- Denonvilliers fascia separates posterior surface of prostate from rectum. It represents the obliterated rectovesical pouch of peritoneum in male.
- Spleen develops in the dorsal mesentery and projects into the greater sac of peritoneal cavity.
- Liver develops in the ventral mesentery and also project into the greater sac.
- Lesser sac is the smaller part of peritoneal cavity lying posterior to the stomach. It is also called as left posterior (sub-hepatic) space.
- Left anterior (subhepatic) space reaches the spleen, but spleen is not projecting into It.
- Spleen lies above the level of transverse colon and is in the supra colic compartment (not the Infra colic).
- Infra colic compartments Ile below the transverse colon and are having the right and left paracolic gutters.
  - This compartment extends till true pelvis. Spleen Is separated from the left paracolic gutter by the phrenocolic ligament
- Phrenocolic ligament attaches the splenic flexure of transverse colon to the diaphragm and supports the anterior end of spleen preventing ID projection into the left paracolic gutter.
- Nerve of Grassi Is a branch of the right vagus. (NEET Pattern 2014)
- Failure to divide this nerve may result in recurrent ulcer.
- Nerve of LatarJet of vagus is seen in the stomach. (NEET Pattern 2014)
- Stomach do not drain into preaortic lymph nodes directly. (NEET Pattern 2013)
- Nerve of Grassi is a branch of the right vagus. (NEET Pattern 2014)
  - Failure to divide this nerve may result in recurrent ulcer.
- Nerve of LatarJet of vagus is seen in the stomach. (NEET Pattern 2014)
- Stomach do not drain into preaortic lymph nodes directly. (NEET Pattern 2013)
- Circular folds are absent in the 1st part of duodenum. (NEET Pattern 2016)
  - The initial 2.5 cm having no folds is seen as the duodenal cap in barium meal radiographs.
- Brunner's glands are related to proximal part of duodenum. (NEET Pattern 2012)
- Length of the intestine is about 8 meter. (NEET Pattern 2015)
  - Small Intestine Is about 6 meters and the large intestine Is about 1.5 meters.
- Minor duodenal papilla is opening of accessory pancreatic duct. (NEET Pattern 2012)
- Arterial supply of the duodenum is by both celiac arteries and superior mesenteric.
- Maximum mucosa associated lymphoid tissue in small Intestine is seen In Ileum.
- Gastroduodenal artery passes behind the first part of duodenum and is prone to bleeding in posterior perforation of duodenal ulcer.
- The shortest part of colon is ascending colon.
- NOT seen in colon Peyer's patches. (NEET Pattern 2012)
- Colon is NOT supplied by the internal iliac artery. (NEET Pattern 2015)
- Commonest anatomical position of appendix is retro-cecal. (NEET Pattern 2013)
- Appendicular artery is a branch of Ileocolic artery. (NEET Pattern 2012)

- Valve of Gerlach is an inconstant fold of mucous membrane resembling a valve at the cecal end of the vermiform appendix. (NEET Pattern 2016)
- Watershed area between superior mesenteric artery and inferior mesenteric artery prone to early ischemia is splenic flexure. (AIIMS 2007)
- Rectum is devoid of sacculations, appendices epiploicae or mesentery.
- Venous blood of liver is drained by hepatic veins.
- Liver weights about 1500-1600 g in males and 1200 g-1300 g in females. (NEET Pattern 2013)
- Bare area of liver is related to hepatic veins draining into inferior vena cava. (NEET Pattern 2015)
- Cystic artery Is usually a branch of which of the right hepatic artery. (NEET Pattern 2012)
  - As a variation, it may arise from the main trunk of the hepatic artery, from the left hepatic artery, or from the gastroduodenal artery.
- Medial boundary of Calot's triangle is formed by common hepatic duct (NEET Pattern 2016)
- In the angle between common hepatic duct and cystic duct Lies the Calot's lymph node of Lund. (NEET Pattern 2012)
- Pancreatic and bile ducts open into duodenum at Ampulla. (NEET Pattern 2013)
- Fibromuscular wall is seen in the Gallbladder. (NEET Pattern 2012)
- Hartmann pouch Is seen In the Gallbladder. (NEET Pattern 2015)
  - Located at the Junction of the neck of the gallbladder and the cystic duct, may be a site where gall stone Impacts.
- Spleen extends from 9th to 11th rib. (NEET Pattern 2012)
- Downward displacement of enlarged spleen is prevented by Phrenico-colic ligament. (NEET Pattern 2016)
- Most common location of accessory spleen is hilum of spleen. (NEET Pattern 2015)
- Right Isomerism is associated with asplenia. (AIPG 2011)
- Structure immediately posterior to pancreatic head is right renal vein (NEET Pattern 2012)
  - Right and left renal veins drain into IVC behind the head of pancreas.
- The neck of pancreas is related on its posterior surface to superior mesenteric vein (AIIMS 2005)
- Pancreas Lies directly anterior to kidney without a fold of peritoneum in between them.
- Kidney is supplied by renal plexus of nerves (along with renal artery) having sympathetic (T10-L1) and parasympathetic (vagus) contributions.
- Nutcracker syndrome: Compression of the left renal vein between the aorta and the superior mesenteric artery, causing hypertension in the kidney with flank pain and sometimes fever and gross hematuria.
- Since Inferior vena cava is not laterally symmetrical, the left renal vein often receives the following : veins left inferior phrenic vein, left suprarenal vein, left gonadal vein (left testicular vein in males, left ovarian vein in females) and left 2nd lumbar vein.
  - This is in contrast to the right side of the body, where these veins drain directly into the IVC.
- The azygous vein is connected to the IVC, while the hemi -azygous vein is connected to the left renal vein.
- While exposing the kidney from behind, nerves is liable to injury are Ilioinguinal nerve, subcostal nerve and Ilio-hypogastric nerve. (AIPG 2004)
- Anterior relations of the right kidney are liver, hepatic flexure, adrenal gland and 2nd (not 4th) part of duodenum. (NEET Pattern 2013)
- Most medially located renal structure is renal pelvis.
  - Arranged medial to lateral: Renal pelvis→ major calyx → minor calyx → renal medulla → renal cortex.
- Renal papilla opens into minor calyx. (NEET Pattern 2012)
  - An apex of the renal pyramid, the renal papilla fits into the cup-shaped minor calyx.

- Kidney hilum contains following structures (anterior to posterior): Renal Vein, renal Artery, and Pelvis (VAP).
- Definitive renal artery arises from aorta. (NEET Pattern 2016)
- Posterior relations of the right kidney are diaphragm, subcostal nerve, Ilioinguinal nerve (but not 11th rib). (NEET Pattern 2016)
- Ureter is not supplied by external iliac artery.
- Genitofemoral nerve Lies on psoas major muscle, and both are posterior (not anterior) relations of ureter. (AIPG 2012)
- Ureteric peristalsis's due to pacemaker activity of the smooth muscle cells in the renal pelvis. (AIIMS 2007)
- During surgeries ureter can identified by the peristalsis.
  - Right adrenal vein drains Into Inferior vena cava. (NEET Pattern 2014)
- Lymphatics of suprarenal gland drain into Paraaortic lymph nodes.
- Left adrenal gland drains into renal vein whereas, right adrenal gland drains into IVC.

Head Neck

- Upper border of thyroid cartilage Lies at C3-4 vertebral level. Common carotid artery bifurcates Into two branches at this level (NEET Pattern 2012); (AIIMS 2007)
- Cricoid cartilage of larynx lies at the C6 vertebra level, which marks the termination of larynx and pharynx and beginning of trachea and esophagus (NEET Pattern 2012)
- Hyoid bone Is located at the level of C3 vertebra (NEET Pattern 2013)
- Sylvian point practically corresponds to the pterion, which is an H-shape suture, contributed by four bones, including the squamous part of temporal bone (NEET Pattern 2015)
- Reid's base line extends from infraorbital margin to center of external acoustic meatus (NEET Pattern 2014)
- The anterior division of the middle meningeal artery runs underneath the pterion (NEET Pattern 2016)
- Posterior cranial fossa has the brainstem which gives cranial nerve 3-12, hence these nerves are present in the fossa. The last six nerves (7-12) enter/exit through the foramina present in the posterior cranial fossa.
- Lesser petrosal nerve passes through the foramen ovale and canaliculus Innominatus in small percentage of population).
- Sternberg's canal is anteromedial to the foramen rotundum (not posterolateral). It connects middle cranial fossa with the nasopharynx. Infection may be carried from the nasopharynx towards the sphenoidal sinus via the canal (AIPG 2009)
- Tumors of anterior cranial fossa damage the olfactory bulb (NEET Pattern 2015)
- Maxillary nerve arises in the trigeminal ganglion (middle cranial fossa), passes through lateral wall of cavernous sinus and leaves the skull through foramen rotundum to enter the pterygopalatine fossa.
- Dorello's Canal is the bow-shaped enclosure surrounding the abducens nerve as it enters the cavernous sinus. It is present at the medial most end of the petrous ridge at the confluence of the inferior petrosal sinus and cavernous sinus (NEET Pattern 2015)
- Skull fracture of anterior cranial fossa causes anosmia, periorbital bruising (raccoon eyes). The cribriform plate of ethmoid bone may be involved, leading to CSF rhinorrhea & ethmoid air sinuses filled with CSF.
- Fracture of the petrous portion of the temporal bone may cause blood or cerebrospinal fluid (CSF) to escape from the ear (otorrhea), hearing loss, and facial nerve damage.
- Muscles of mastication are supplied by anterior division of mandibular nerve except medial pterygoid being supplied by main trunk (AIPG 2011)
- Masseteric nerve is a branch from anterior division of mandibular nerve (NEET Pattern 2012)
- Mandibular nerve carries both the afferent and the efferent limbs of the jaw jerk reflex.

- Meningeal branch (nervus spinosus) arise from the main trunk of mandibular nerve (NEET Pattern 2013)
- Recurrent laryngeal nerve which hooks around the subclavian artery on the right and around the arch of the aorta lateral to the ligamentum arteriosum on the left to ascends in the groove between the trachea and the esophagus. (NEET Pattern 2016)
- Injury to vagus nerve leads to loss of palate elevation and the uvula deviates toward the intact side (away from the side of the lesion) during phonation.
- Vagus nerve has the largest distribution in the body and contributes about 75% to the parasympathetic system (NEET Pattern 2016)
- Superior sagittal sinus Lies in the midline structure called falx cerebri and is unpaired (NEET 2012)
- Superior petrosal sinus is a draining channel for cavernous sinus (NEET Pattern 2014)
- Great cerebral vein of Galen is joined by the Inferior sagittal sinus to drain into the straight sinus (NEET Pattern 2015)
- Superior cerebral veins (eight to twelve) drain the superior, lateral, and medial surfaces of the hemispheres into the superior sagittal sinus (NEET pattern 2014)
- Superficial middle cerebral vein runs along the lateral sulcus draining most of the temporal lobe into the sphenoparietal sinus or cavernous sinus (NEET pattern 2016)
- Abducent nerve lies inferolateral to the Internal carotid artery inside the cavernous sinus (NEET Pattern 2016)
- Two internal cerebral veins on each side unite to form the great cerebral vein of Galen in the midline (NEET Pattern 2012)
- Anterior half of nasal cavity (including anterior part of nasal septum) drains into submandibular nodes (NEET Pattern 2015)
- Deep cervical nodes lie along internal jugular vein (NEET Pattern 2013)
- Platysma develops in second pharyngeal arch and is supplied by facial nerve (cervical branch).
- The pulsations of facial artery can be felt at two sites, at the base of the mandible close to anteroinferior angle of the masseter and about 1.25 cm lateral to the angle of the mouth (NEET Patten 2012)
- Lymphatics from the central part of the lower lip drain into submental lymph nodes. Lymphatics from lateral parts of lower lip and whole of upper lip drain into submandibular lymph nodes (NEET Patten 2016)
- Risorius is a muscle of facial expression, to produce a smile, albeit an Insincere-looking one that does not involve the skin around the eyes (NEET Pattern 2012)
- Palpebral part orbicularis cell close eyelids as in blinking or winking (NEET Pattern 2013)
- Fascia around the brachial plexus is called as axillary sheath and is a derivative of prevertebral fascia (AIIMS 2008; 2011)
- Cervical sympathetic chain is NOT a content of carotid sheath but is closely related to posterior wall of the sheath (JIPMER 2010)
- The posterior belly of the digastric and stylohyoid muscles are innervated by the facial nerve, whereas the anterior belly of the digastric and mylohyoid muscles are innervated by the trigeminal nerve.
- The geniohyoid and thyrohyoid muscles are innervated by C1-3 through the hypoglossal nerve.
- Taste sensation from anterior 2/3rd of tongue is carried by chorda tympani (branch of facial nerve), towards the facial nerve and geniculate ganglion (NEET Pattern 2012)
- Anterior 2/3rd of the tongue is demarcated by sulcus terminalis, a V shape structure which divides the tongue into anterior two-thirds (oral part) and posterior one-third (pharyngeal part) (AIIMS 2016)
- Sensory supply of parotid is derived from auriculotemporal nerve and great auricular nerve (C2 and C3). The C2 fibers are sensory to the parotid fascia.

- Lesser petrosal nerve derives preganglionic fibers from tympanic nerve, branch of glossopharyngeal nerve (NEET Pattern 2014)
- Stensen's parotid duct crosses the masseter, pierces the buccinator muscle, and opens into the vestibule of the oral cavity opposite the upper second molar tooth (NEET Pattern 2012)
- Sympathetic root of otic ganglion is from plexus around middle meningeal artery, which arises from the superior cervical ganglion (NEET Pattern 2012)
- The plane between the superficial and deep lobes in which facial nerve lie is called Patsy's facto-venous plane. It helps the surgeons to remove the parotid tumor without damaging the facial nerve.
- Otic ganglion supplies Parotid gland (NEET Pattern 2012)
- Preganglionic fibers to the submandibular ganglion arise from Superior salivatory nucleus (NEET pattern 2012)
- Lingual nerve loops around submandibular duct (NEET pattern 2015)
- Bed of tonsil is formed by Superior constrictor muscle (NEET Pattern 2012)
- During Acute tonsillitis pain in the ear is due to involvement of Glossopharyngeal nerve (NEET Pattern 2018)
- Lesion of the vagus nerve causes deviation of the uvula toward the opposite side of the lesion on phonation because of paralysis of the musculus uvulae (elevator of uvula).
- Sensory fibers from the taste buds in the hard and soft palate travel along facial nerve (AIIMS 2005)
- Soft palate muscles are supplied by cranial accessory nerve (NEET Pattern 2012)
- Lower border of pharynx is the level of C6 vertebra (NEET Pattern 2015)
- Nasopharynx is lined by ciliated columnar epithelium (NEET Pattern 2016)
- Pyriformis fossa is located in pharyngeal part of pharynx (NEET Pattern 2012)
- Passavant ridge is formed by palatopharyngeus and superior constrictor muscle (NEET Pattern 2012)
- Sinus of Morgagni Is between Superior constrictor and skull (NEET pattern 2014)
- Levator veil palati passes through sinus of Morgagni (JIPMER 2017)
- Rouvière's node is the most superior of the lateral group of the retropharyngeal lymph nodes found at the base of the skull (NEET Pattern 2012)
- Eustachian tube opens I nasopharynx behind posterior end of inferior turbinate (NEET Pattern 2012)
- Gerlach's tonsil is the lymphoid collection at the pharyngeal opening of auditory tube (tuba) tonsils) (NEET Pattern 2013)
- The cricopharyngeus muscle, the sphincter of the upper esophageal opening, remains closed except during deglutition (swallowing) and emesis (vomiting).
- Physiologically, the LES is a 3-5 cm long segment of tonically contracted smooth muscle, 1-2 cm of which are situated below the diaphragm. (NEET Patten 2016)
- Distance of the lower esophageal sphincter from the upper Incisors Is 40 cm (some authors mention 37.5 cm) (NEET Pattern 2012, 16)
- Cricopharyngeus muscle Lies at the beginning of esophagus at 15cm from upper incisors (NEET Pattern 2016)
- Esophagus begins at the lower border of cricoid cartilage (C6 vertebral level) and opens into stomach at T11 vertebral level (NEET Pattern 2015)
- Nerve supply of larynx above level of vocal cord is superior laryngeal nerve (NEET Pattern 2018)
- Larynx has nine cartilages out of which only the cricoid makes a complete ring (signet shape) (AIMS 2013)
- The anteroposterior diameter of glottis is 24 mm in adult males and 16 mm in adult females (NEET Pattern 2013)
- Larynx is situated in front of laryngopharynx, extends from the root of the tongue to the trachea and Lies in front of the C3, 4, 5 vertebrae in a normal adult male (NEET Pattern 2015)

- Lymphatic drainage of the larynx is to the deep cervical nodes (NEET Pattern 2012)
- Tensor of vocal cord is cricothyroid muscle (NEET Pattern 2018)
- Inner ear reaches adult form at about 10 weeks, adult size at around 20 weeks and adult functionality at 26th week (NEET Pattern 2016)
- Tympanic membrane is derived from all the three germ layer (NEET Pattern 2012)
- Greater part of auricle is supplied by greater auricular nerve (branch of the cervical plexus).
- Greater auricular nerve supplies the lobule of ear on medial (cranial) as well as lateral (outer) surface (AIIMS 2015)
- The cartilaginous part of external auditory canal forms the outer one-third (8 mm) of the meatus and the bony part forms the inner two-third (16 mm) - (NEET Pattern 2014)
- Tympanic membrane is placed obliquely making an angle of about 55° with the floor of the external acoustic meatus (NEET Pattern 2013)
- Type of Joints between ear ossicles are synovial Joints (AIPG 2008)
- Mastoid antrum is present in petrous portion of the temporal bone (NEET Pattern 2015)
- Tympanic branch of the middle ear contributes to tympanic plexus and is derived from glossopharyngeal nerve (NEET pattern 2012)
- Distance between tympanic membrane (lateral wall) and promontory (medial wall) of middle ear cavity is 2 mm
- The footplate of stapes doses the oval window and is attached to its margin by annular ligament (AIIMS 2003)
- The medial wall of middle ear cavity shows promontory, a rounded prominence in the centre produced by first (basal) turn of the cochlea.
- The floor of middle ear cavity is formed by a thin plate of bone, which separates the tympanic cavity from the jugular bulb/Internal Jugular vein (NEET Pattern 2012)
- The tympanic end of Eustachian tube is situated in the anterior wall of the middle ear (NEET Pattern 2013)
- Superior wall (roof) of middle ear is formed by a thin plate of bone called tegmen tympani, which separates the tympanic cavity from the middle cranial fossa (NEET Pattern 2015)
- Muscle entering middle ear from pyramid apex is Stapedius (NEET Pattern 2012)
- Inner ear is present in petrous part of temporal bone (NEET pattern 2014)
- Horizontal semi-circular canal is also called lateral semi-circular canal.
- Bill's bar: A vertical crest that separates the superior fundus in the internal auditory canal into anterior and posterior portions containing the facial nerve (& nervus intermedius) and the superior vestibular nerve, respectively. (AIIMS 2011)
- Olfactory nerve is pure sensory for the sensation of smell (NEET Pattern 2016)
- The shortest (length) cranial nerve is olfactory nerve (CN I).
- Kiesselbach's plexus Is the commonest site of bleeding (90% of cases). It Is situated in the anterior inferior part of nasal septum, just above the vestibule.
- Little's area is present on antero inferior nasal septum (NEET Pattern 2015)
- Woodruff's plexus is situated in relation to posterior end of inferior turbinate. It is a site of posterior epistaxis in adults. The plexus is venous in origin and have no muscle walls leading to poor hemostasis.
- Inferior turbinate is a facial bone which extends horizontally along the lateral wall of the nasal cavity and articulates with bones like ethmoid, maxilla, palatine and lacrimal bones (NEET pattern 2012)
- Parts of ethmoid bone are Agger nasi, Bulla ethmoidalis, Uncinate process but not Inferior turbinate (NEET Pattern 2014)
- Olfactory region in nose is above superior turbinate (NEET Pattern 2013)

- The roof of nasal cavity, formed by the cribriform plate of ethmoid bone, has olfactory epithelium (NEET Pattern 2014)
- Rhinion is the soft-tissue correlate of the osseocartilaginous Junction of the nasal dorsum (NEET Pattern 2012)
- Muscles of nose are Procerus, Compressor naris, Depressor Septi but not Angularis oris (NEET Pattern 2016)
- Anguli oris is a facial muscle associated with frowning.
- Posterior ethmoidal sinus opens in the superior meatus.
- Nasolacrimal duct opens In the Inferior meatus, on anterior aspect, covered by Hasner's valve
- Lacrimal bone does not contribute to the formation of Nasal septum (AIPG 2008)
- Lymphatic drainage of nose is towards Submandibular nodes, retropharyngeal nodes and Upper (not lower) deep cervical nodes (NEET Pattern 2016)
- Nose lymphatics do not drain into lower deep cervical nodes.
- Haller cell represents an extension of anterior ethmoidal air cells extending into the infra-orbital margin (roof of maxillary sinus) (AIMS 2009).
- Lamina papyracea separates nose from orbit (NEET pattern 2013, 15)
  - It is a bone plate which forms the lateral surface of the labyrinth of the ethmoid bone, covers in the middle and posterior ethmoidal cells and forms a large part of the medial wall of the orbit.
- Floor of orbit is contributed by Maxilla, Palatine and Zygomatic (bone but not Ethmoid) - (AIMS 2013)
  - Ethmoid bone forms the medial wall of the orbit.
- Maxilla gives maximum contribution to floor of orbit (NEET Pattern 2012)
- Blow out fracture of orbit most commonly Involves floor > medial wall. (NEET Pattern 2018)
- Optic vesicle is derived from an evagination developing on either side of the forebrain neuroectoderm (NEET Pattern 2016)
- Optic vesicle forms the optic cup and optic stalk (NEET Pattern 2015)
- Optic cup forms inner neural retinal epithelium and outer pigmented layer of the retina (NEET Pattern 2015)
- Corneal endothelium develops from neural crest cells.
- Crystalline lens develops from surface ectoderm (NEET Pattern 2012)
- PAX6 is the key regulatory gene for eye and brain development (NEET Pattern 2016)
- Surface ectoderm forms the eye lens, first layer of cornea and glands exterior to eyeball like lacrimal gland (but sclera is a derivative of neural crest cells) - AIIMS 2006
- Sclera is thinnest posterior to attachment of superior rectus (NEET Pattern 2012)
- Ligament of Lockwood's is the suspensory ligament of eyeball, between the medial and lateral check ligaments and enclosing the inferior rectus and Inferior oblique muscles of the eye (NEET Pattern 2015)
- Cornea has an outer epithelium at surface lined by non-keratinized stratified squamous epithelium (NEET Pattern 2012)
- Intra-orbital length of optic nerve is 30 mm (NEET Pattern 2016)
- The total length of the optic nerve averages 50 mm: 1 mm for the Intraocular segment, 25 mm for the Intra-orbital segment, 10 mm for the intra-canalicular segment, and 14 mm for the intracranial segment
- Superior oblique Is the longest and thinnest extraocular muscle (NEET Pattern 2012)
- Primary action of superior oblique is Inward rotation (Intortion) of the eyeball (NEET Pattern 2012)
  - Secondary actions are depression and abduction.
- Primary action of Inferior oblique is outward rotation (extortion) of the eyeball (NEET Pattern 2015)
  - Secondary actions are elevation and abduction.

- Primary action of superior rectus is elevation of eyeball (NEET Pattern 2012)
  - Secondary actions are adduction and intorsion.
- Inferior oblique Is supplied by the third cranial nerve (NEET Pattern 2012)
- Constrictor pupillae is supplied by the parasympathetic fibers from Edinger Westphal nucleus, carried by oculomotor nerve (NEET Pattern 2016)
- Parasympathetic fibers to eye come via ciliary ganglion (NEET Pattern 2015)
  - Parasympathetic supply to eye is meant to control the smooth muscles sphincter pupillae and ciliaris.
- Cornea is supplied by Nasociliary branch of ophthalmic nerve (AIIMS 2015)
  - it Is supplied by long and short ciliary nerves branches of nasociliary nerve, which itself is a branch of ophthalmic division of the trigeminal nerve.
- Lesion of the ophthalmic division cannot mediate the afferent limb of the corneal reflex by way of the nasociliary branch (the facial nerve mediates the efferent limb).
- Anterior lobe (adenohypophysis) of pituitary develops from Rathke's pouch (ectodermal diverticulum of the primitive oral cavity) (NEET Pattern 2013)
- Herring bodies are neurosecretory structures present in the neurohypophysis (posterior pituitary) (NEET Pattern 2012)
- Isthmus of thyroid gland usually anterior to the second, third and fourth tracheal cartilages ring (NEET Pattern 2015)
  - Some authors mention it as second and third ring, most precisely 3rd ring.
- Isthmus of thyroid gland lies at C7 vertebral level (NEET Pattern 2015)
- Superior thyroid artery runs along with external laryngeal nerve towards the thyroid gland (NEET Pattern 2016)
- Inferior thyroid artery supplies the recurrent laryngeal nerve and Lies very close to the near the base of the thyroid lobe.
- Inferior thyroid artery is a branch of Thyro cervical trunk (NEET Pattern 2015)
- Inferior thyroid vein drain into the brachiocephalic vein (NEET Pattern 2012)
  - Superior and middle thyroid veins drain into the internal Jugular vein.
- Ligament of Berry In thyroid fixes to Cricoid cartilage (NEET Pattern 2014)
- Lymphatic drainage of thyroid gland is mainly into deep cervical nodes (NEET Pattern 2015)
- Elevation of mandible is brought about by the contraction of MTM (Masseter, Temporalis and Medial pterygoid) muscles.
- Depression Is carried out by digastric, geniohyoid and the mylohyoid muscles along with the lateral pterygoid.
- Lateral pterygoid is attached to intra articular disc of temporomandibular joint (NEET Pattern 2016)
  - Spasm or excessive contraction of lateral pterygoid can result in dislocation of mandible (AIIMS 2003)
- Lateral pterygoid is depressor of mandible to open the mouth (NEET Pattern 2012, 14)
- TM Joint has a capsular ligament strengthened by temporomandibular, sphenomandibular, and stylomandibular ligaments (but not by Tympanomandibular ligament) (NEET Pattern 2014)
- The central part of the articular disc in TM Joint Is avascular and not Innervated (AIIMS 2002)

Lower Limb

- Note: Angle of torsion is between the axis of head and neck of the femur and transverse axis of femoral condyles (7° to 12°).
- Tibia is a pre-axial bone. It has no articulation with patella.
- Secondary centre for the upper end is present at birth and fuses with the shaft by 16 years in females and 18 in males.
- Nutrient artery is a branch of the posterior tibial artery (may also be a branch from the anterior tibial artery)
- Nutrient foramen is present on shaft, directed away from the upper growing end.
- The strongest flexor of hip joint is iliopsoas muscle.
- Hip flexion is done by sartorius, pectineus, rectus femoris (but not gluteus maximus).
- The iliofemoral ligament of Bigelow (that forms an inverted Y shape) is the strongest ligament of the hip joint and limits hyperextension.
- Langenbeck triangle has its apex at the anterior superior spine of the ilium, base along the anatomical neck of the femur, and its external side by the external face of the greater trochanter of the femur (JIPMER 2015).
- Anterior cruciate ligament is taut during knee extension and posterior cruciate ligament during knee flexion.
- Coronary ligament is that part of the capsule which lies between the periphery of menisci and the tibial condyle. It attaches the lower border of both the menisci to the tibia (also called as tibio-meniscal ligament) (AIIMS 2012)
- Morphologically, the medial collateral ligament represents the degenerated tendon of insertion of the ischial head of the adductor magnus, & fibular ligament represents the degenerated tendon of the peroneus longus (NEET Pattern 2016).
- Spring (plantar calcaneonavicular) ligament supports the head of the talus and the medial longitudinal arch
- If this ligament fails, the navicular and calcaneus separate, allowing the talar head, which is the highest point of the medial arch, to descend, leading to a flat-foot deformity (NEET Pattern 2014)
- Note: Spring ligament is not attached to head of talus (NEET Pattern 2013)
- Dermatomal supply Just below Inguinal ligament Is LI (NEET Pattern 2016)
- Perianal skin is supplied by S4 (and 55) root value (NEET Pattern 2012)
- Slip disc at L5-S1 vertebrae; Involves S-1 root value, leading to Involvement of corresponding dermatome on lateral side of the foot and little toe (sural nerve territory).
- Great toe has LS dermatome; little toe and heel - S1; 52 lies on the posterior aspect of lower limb.
- The dorsal and ventral axial lines both reach the ankle Joint, ventral reaches the medial aspect
- Meralgia paresthetica is due to involvement of lateral cutaneous nerve of thigh. There is constant pain and abnormal perception in the outer side of the thigh, occasionally extending to the knee. (AIIMS 2015)
- Root value of medial cutaneous nerve of thigh Is L2, L3. It is a branch of the anterior division of the femoral nerve. (NEET Pattern 2014)
- Most commonly used nerve in the body for grafting is sural nerve.
- Longest cutaneous nerve in the body is saphenous nerve.
- Some authors equate sacrotuberous ligament with the degenerated developmental remnant of the tendon of the long head of the biceps femoris.
- Tibialis anterior works for dorsiflexion (extension) and inversion (NEET Pattern 2015); Nerve supply: Deep peroneal (anterior tibial) nerve.
- It is active in both stance and swing phases of walking cycle

- Action of peroneus longus is: Eversion (turn the sole lateral). It also maintains transverse (and lateral longitudinal) plantar arch.
- Nerve supply: Superficial peroneal nerve (branch of common peroneal nerve).
- Violent Inversion of the foot will lead to avulsion of tendon of the peroneus brevis attached to the tuberosity of the 5th metatarsal (AIIMS 2007)
- Peroneus longus and brevis cause eversion of foot at subtalar Joint.
- Tibialis anterior and posterior, both cause inversion of foot at subtalar Joint
- Tibialis posterior takes origin from inner posterior borders of both tibia & fibula and also the interosseous membrane (NEET Pattern 2014). It has extensive attachments on the foot bones but is not attached to talus bone.
- The bones involved in the transverse arch are the bases of the five metatarsals, the cuboid and the cuneiforms. The intermediate and lateral cuneiforms are wedge-shaped and thus adapted to maintenance of the transverse arch.
- The transverse arches are strengthened by the interosseous, plantar, and dorsal ligaments, by the short muscles of the first and fifth toes (especially the transverse head of the Adductor Militias), and by the Peroneus longus, whose tendon stretches across between the piers of the arches.
- Most important factors in maintaining the transverse arch of the foot ate tendons of peroneus longus and tibialis posterior.
- Keystone of medial longitudinal arch is talus and for lateral longitudinal arch is cuboid.
- Most vulnerable part of the medial longitudinal arch is talocalcaneonavicular joint.
- Most vulnerable part of the lateral longitudinal arch is calcaneocuboid joint
- Most important ligament for maintaining the arches of the foot is spring ligament.
- Commonest deformity of the foot Talipes equinovarus
- The kinetic energy of body is least in mid-stance phase of walking cycle, while the body is in single support phase (one foot on ground and the other foot being in air). Kinetic energy is maximum in double support (both the feet on ground).
- Tibialis anterior is active in both swing and stance phase of walking cycle (AIIMS 2003).
- The blood supply to the lower limb is derived from the lateral branch of the fifth lumbar intersegmental artery, which continues into the limb bud as the axial artery.
- The preaxial vein becomes the long saphenous vein, which drains into the femoral vein at the saphenous opening and postaxial vein becomes the short saphenous vein, which passes deep and joins the popliteal vein.
- Superficial external pudendal artery is a branch of femoral artery (NEET Pattern 2015)
- Superficial epigastric artery is a branch of femoral artery (NEET Pattern 2015)
- Halfway between the anterior superior iliac spine and the pubic symphysis lies the mid inguinal point (MW). Femoral artery pulse is felt at the mid inguinal point ± 1 cm either side (NEET Pattern 2012).
- Note: It is mid-inguinal point and not the mid-point of inguinal ligament.
- Unique feature of the lateral compartment of the leg is that it does not have its own artery.
- Largest nutrient artery in the body is nutrient artery to tibia (a branch of the posterior tibial artery).
- Largest and most important branch of the posterior tibial artery is peroneal artery.
- There are no perforator veins below the inguinal ligament (AIIMS 2007)
- Hunterian perforator is present in mid-thigh at the lower part of adductor (Hunterian) canal. It connects great saphenous vein with the femoral vein (NEET Pattern 2013)
- Dodd's perforator is present in distal thigh and connect great saphenous vein with femoral vein (NEET Pattern 2016)

- Incompetent valves affecting perforating veins of lower limb makes the blood flow from deep to superficial direction.
- This makes the superficial veins overfilled with blood and they become dilated, elongated and tortuous - varicose veins (AIIMS 2005)
- Talo-calcaneonavicular joint is a Ball & Socket type of synovial joint (AIIMS 2017)
- Tarsometatarsal Joint (Lisfranc Joint) is the articulation of the tarsal bones with the metatarsals.

Neuro Anatomy

- Corpus callosum is commissural type of fibers (NEET Pattern 2012)
- It connects the left and right cerebral hemispheres and facilitates interhemispheric communication.
- Largest commissural fibers are seen in corpus callosum (NEET Pattern 2016)
- Neural tube begin to dose from cervical region (AIPG 2009)
  - Neural tube closure begins in the cervical region and proceeds bi-directionally towards cranial and caudal region.
- Caudal (posterior) neuropore closes at day 28 (three days later (25+3) to cranial (anterior) neuropore.
- Alpha-fetoprotein levels are elevated in Anencephaly, Myeloschisis, and Omphalocele (but in Down syndrome the levels are down).
- The retina is an outgrowth of the Diencephalon (NEET Pattern 2014)
- Diencephalon extends into the eyeball to become retina and optic nerve.
- Myelination of optic nerve begins at 7 months of gestational age (NEET Pattern 2016) terminates shortly after birth at the level of the lamina cribrosa.
- First commissure to develop is anterior commissure (NEET Pattern 2013)
- CSF escapes the fourth ventricle into the subarachnoid space via three foramina: One midline Magendie and two lateral Luschka (PGIC 2000)
- Arachnid villi responsible for cerebrospinal fluid absorption protrude mainly in the superior sagittal sinus (AIIMS 2002)
- Third ventricle is the midline ventricle located in diencephalon (NEET Pattern 2012)
- Cerebral aqueduct of Sylvius is a cavity within the mesencephalon (NEET Pattern 2013)
- Ventricles of brain are lined by ependymocyte (NEET Pattern 2015)
  - These are cuboidal or columnar in shape with tuft of cilia.
- Lateral ventricle is connected in third ventricle by foramen of Monro (NEET Pattern 2013)
- Pineal gland forms Posterior boundary of third ventricle (NEET Pattern 2013)
- Foramen of Magendie is the central opening of 4th ventricle (NEET Pattern 2013)
- Fascial colliculus is located at pons (AIPG 2008)
- Hippocampus is concerned with recent memory traces and is related to the inferior (temporal) horn of lateral ventricle.
- Lunate sulcus is an operculated sulcus (NEET Pattern 2012)
- Primary visual area is located in the walls of posterior part of calcarine sulcus.
  - It shows lines (stria) of Gennari's and is also called as striate cortex.
- Primary auditory area (41, 42) is present in the superior temporal gyrus (NEET Pattern 2015)
- Broca's area is present in Inferior frontal gyms (NEET Pattern 2012)

- Heschl's gyrus in brain is located in Primary auditory cortex (JIPMER 2016)
  - It is the transverse temporal gyrus in the area of primary auditory cortex buried within lateral sulcus.
- Visual image of a word is projected from the visual cortex (area 17) to the visual association cortices (areas 18 and 19) and next to the angular gyrus (area 39).
- Further processing occurs in Wernicke speech area (area 22), where the auditory form of the word is recalled.
- Arcuate fasciculus carries this information to Broca's speech area (areas 44 and 45), which has motor speech programs to control the vocalization mechanisms of the precentral gyrus (4).

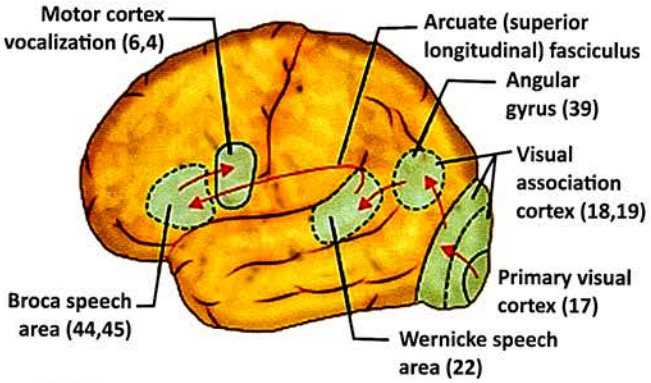


Fig. : Cortical areas involved in language production

- Broca's expressive aphasia patient presents with hesitant speech (fluency is decreased), speaks in few words (and not in sentences).
  - The planning of movement of speech muscles is compromised and muscles are unable to articulate properly to produce meaningful voice.
  - Comprehension of language is good.
  - They are aware of their language disorder and may get frustrated by the deficit
- In Wernicke's receptive aphasia, comprehension (understanding) of the language Is compromised and the patient Incessantly speaks In Incoherent (irrelevant) sentences, making little sense.
  - They are often unaware of their mistakes.
- Lesion in the arcuate fasciculus results in conduction aphasia, with poor naming and problems in repetition of speech.
  - The comprehension of language and fluency of speech is intact.
- Patients are aware of their errors but have significant difficulty correcting them.
- Globus pallidus and putamen are present in Basal ganglia (NEET Pattern 2012)
- Amygdaloid nucleus is a part of basal ganglia.
- Neural pathway passing through genu of internal capsule is cortico nuclear tract (NEET Pattern 2014)
- Sub lentiform part of the internal capsule are associated with acoustic radiation.
- Arterial supply to internal capsule is discussed in two parts: superior (dorsal) and inferior (ventral) part.
  - Superior (dorsal) part of the anterior limb, genu and the posterior limb are supplied by the lenticulo-striate branches of middle cerebral artery.
  - Inferior (ventral) part of internal capsule:
- Anterior limb: Anterior cerebral artery (including recurrent branch of Heubner)
- Genu: Internal carotid artery
- Posterior limb: Anterior choroidal artery
- Sub lentiform and retro lentiform parts are chiefly supplied by anterior choroidal artery.
- Nucleus fasciculatus (another name for cuneatus) is seen in Medulla oblongata (NEET Pattern 2012)

- Nuclei cuneatus and gracilis are present in Medulla oblongata.
- Facial nerve does NOT arise from the medulla (NEET Pattern 2014)
- Nucleus ambiguus is postero-medial to olive (NEET Pattern 2014)
- Olive is seen in Medulla oblongata (NEET Pattern 2014)
- Internal arcuate fibers of medulla comes from Nucleus gracilis and cuneatus (NEET Pattern 2015)
- These fibers cross to the opposite side to continue as the medial lemniscus.
- Trochlear nerve arises from lower midbrain and Abducent arises from pons.
- Facial nerve does NOT have fibers in nucleus ambiguus (NEET Pattern 2012)
- CN VIII is associated with special somatic afferent nuclei.
- Dorsal nucleus of vagus belongs to the general visceral efferent column (AIIMS 2004)
- CN V is not a somatic efferent nerve (AIPG 2008)
- Purkinje cells fibers from the cerebellum end in cerebellar nuclei (NEET Pattern 2014)
  - The fibers are neuro inhibitory (neurotransmitter Is GABA).
- Only tract present in middle cerebellar peduncle is Pontocerebellar (NEET Pattern 2015)
- In cerebellar lesion NOT seen Is Resting tremors.
- Deep cerebellar nuclei are DEFG: Dentate, Emboliform, Fastigii and Globose
- Superior cerebellar peduncle is attached to midbrain; middle to pons and inferior to medulla oblongata.
- Evolution wise, the latest and the lateral-most nucleus is dentate
  - The oldest and medial most Is Fastigii nucleus.
  - Fastigii nucleus, as believed to be derived from fish (evolution-wise) is for maintenance of axial balance.
- Dentato-rubro-thalamic tract passes through the superior cerebellar peduncle to reach the contra lateral thalamus.
- Cerebellar cortex has 3 layers: Outermost molecular layer - 2 cells (stellate and basket); middle layer - Purkinje cells and Inner (deeper/ granular) layer- 2 cells (granule and Golgi).
- In adults the weight ratio of cerebellum to cerebrum is approximately 1:10 and in infants 1:20.
- In adults the spinal cord normally ends at the lower border of the L1 vertebra (NEET Pattern 2015)
- Spinal cord termination in a baby at birth is at upper border of L3 vertebra.
- Subarachnoid space ends at S2 vertebra (NEET Pattern 2012)
- Ligamentum denticulatum has 21 pair of teeth like projections (NEET Pattern 2016)
- Pain and temperature is carried by the lateral spinothalamic tract, whereas, anterior spinothalamic tract carries the crude touch and light touch.
- Pyramidal tract Is a motor tract and Is concerned with control of fine and skilled voluntary motor activity.
- Dorsal spinocerebellar tract is concerned with unconscious proprioception, mainly from the lower limbs.
- Upper limb proprioception is carried by the cuneocerebellar tract.
- Posterior column (dorsal column) of spinal cord has two fasciculi: gracilis and cuneatus.
- Intraocular muscle supplied by Edinger-Westphal nucleus Is Ciliary muscle (NEET Pattern 2014)
- Synaptic transmission in autonomic ganglia is Cholinergic
  - Synaptic transmission in autonomic ganglia (sympathetic and para-sympathetic) Is cholinergic.
- Preganglionic parasympathetic neurons are located in brainstem and sacral spinal cord.
- Nerve carrying parasympathetic fibers are Cranial nerves 3, 7, 9, 10 and sacral nerves S2-4 (AIIMS 2016)
- Exophthalmos Is NOT a sign of stellate ganglion block (AIPG 2006)
- Superior salivatory nucleus controls Lacrimal, Palatine, Sublingual salivary glands.

- Pancoast tumor (superior pulmonary sulcus tumor) is a malignant neoplasm of the lung apex which may cause a lower trunk brachial plexopathy (which causes severe pain radiating toward the shoulder and along the medial aspect of the arm and atrophy of the muscles of the forearm and hand) and a lesion of cervical sympathetic chain ganglia with Homer syndrome (ptosis, enophthalmos, miosis, anhidrosis, and vasodilation).
- Vertebral arteries of both sides unite to form basilar artery (NEET Pattern 2015)
- Branches of basilar artery: Paramedian, Anterior inferior cerebellar artery, Labyrinthine artery, Superior cerebellar artery, Posterior cerebral artery (PGIC 2002)
- Major supply of medial surface of cerebral hemisphere Is Anterior cerebral artery (NEET Pattern 2012)
- Chief artery of lateral surface of cerebral hemisphere Is Middle cerebral artery (NEET Pattern 2013)
- Posterior communicating artery is a branch of internal Carotid artery.
- Posterior communicating artery connects Posterior cerebral artery with internal Carotid artery (NEET Pattern 2015)
- Medulla oblongata is supplied by the branches of vertebral, anterior spinal and posterior spinal, posterior inferior cerebellar and basilar arteries.
- Labyrinthine artery is a branch of anterior inferior cerebellar artery, passes through internal auditory meatus (along with facial and vestibulo-cochlear nerve) and supply the inner ear.
- Occasionally labyrinthine artery Is a direct branch of basilar artery.
- Branches of the vertebral artery are: Anterior spinal, Posterior spinal and Posterior Inferior cerebellar artery.
- Anterior inferior cerebellar artery is a branch of basilar artery.
- Ankle jerk - Spinal segment S-1; Nerve: Tibial; Muscle: Gastrocnemius.
- Knee jerk - Spinal segment L-2, 3, 4; Nerve: Femoral; Muscle: Quadriceps.
- Biceps jerk - Spinal segment C-5, 6; Nerve: Musculocutaneous; Muscle: Biceps.
- Supinator reflex - Spinal segment C-5, 6; Nerve: Radial; Muscle: Brachioradialis.
- Triceps reflex - Spinal segment C-7, 8; Nerve: Radial; Muscle: Triceps. Memory aid: S-1; L-2, 3, 4; C-5, 6; C-7, 8.

Pelvis & Perineum

- Pelvic organ with thickest muscular walls is uterus.
- Bulk of semen is formed by the secretion of seminal vesicles.
- Sacred bone is sacrum and tall bone is coccyx.
- Largest branch of the anterior division of the internal iliac artery is inferior gluteal artery.
- Inferior rectal artery is a branch of internal pudendal artery.
- Superior rectal vein drains the upper regions of rectum and anal canal into vein of hindgut - inferior mesenteric vein.
- Most fixed part of the urinary bladder is neck of the urinary bladder.
- Uterus and vagina in the male is represented by Prostatic utricle.
- Prostate gland in the females is represented by Paraurethral glands (of Skene).
- Least movable part of the uterus is cervix.
- Most common site of fertilization is ampulla of the uterine tube.
- Most important ligaments of the uterus is transverse cervical ligaments (of Mackenrodt's).
- Most important surgical relation of the uterine artery where it crosses the ureter antero superiorly (from lateral to medial side) —Water below the bridge.
- Most prominent lateral curvature of the rectum is middle lateral curvature (being convex to the left).
- Most important is Houston valve is the third transverse rectal fold of the mucous membrane.

- Chief artery of the rectum is superior rectal artery and vein is superior rectal vein.
- Location of primary internal plies in lithotomy position are 3, 7, and 11 o'clock positions

Thorax

- The horizontal sternal plane is 'traditionally' reported to pass through the intervertebral disc between the fourth and fifth thoracic vertebrae posteriorly.
- Here lies the sternal angle (of Louis), which is at the junction between manubrium and body of the sternum.
- It indicates the level where (1) the second rib (costal cartilage) articulate with the sternum, (2) the aortic arch begins and ends, (3) the trachea bifurcates into the right and left primary bronchi, (4) Pulmonary trunk divides into right and left pulmonary arteries, (5) Upper border of heart, (6) the site where the superior vena cava penetrates the pericardium to enter the right atrium, (7) it marks the plane of separation between the superior and Inferior mediastinum, (8) Azygos vein arches over the root of right lung to end in the superior vena cava.
- Heart tube is formed at day 22 (week 4) of development (NEET Pattern 2016)
- Heart tube is formed in Hyaluronic acid secreted by myocardium (NEET Pattern 2016)
- Heart is fully developed at 10th week (3rd month) of intrauterine life (NEET Pattern 2013)
- The left horn of sinus venosus undergoes regression and forms the coronary sinus (NEET Pattern 2013)
- Foramen ovate closes because of fusion of Septum primum + Septum secundum (NEET Pattern 2012)
- Absence of Aorta Pulmonary (AP) septum (also called cono-truncal septum) leads to persistent (patent) truncus arteriosus.
- Unequal division of the conus cordis resulting from anterior displacement of the cono-truncal septum gives rise to a narrow pulmonary trunk-pulmonic stenosis and a wide aorta. This leads to the complex of tetralogy of Fallot. (AIIMS 2003)
- Remnant of umbilical artery Is medial umbilical ligament (NEET Pattern 2016)
- Ligamentum tares is the adult remnant of left umbilical vein (NEET Pattern 2016)
- Lateral umbilical fold of peritoneum is produced by inferior epigastric vessels (NEETPattern 2016)
- Median umbilical ligament is derived from urachus (NEETPattern 2013)
- Transverse pericardial sinus lies between arterial and venous tubes (NEET Pattern 2016)
- Ossification of ribs begins toward the end of the second month of fetal life (8 -10 weeks) (NEET Pattern 2016)
- Scalene tubercle is a feature of 1st rib (NEET Pattern 2015)
- 8, 9 and 10th ribs are attached to 7th rib by synovial Joint (NEET Pattern 2014)
- 8th rib do not articulate with sternum and is a vertebrochondral rib, as it attaches to the costal cartilage of the next higher rib anteriorly (NEET Pattern 2014)
- All costochondral joints are 1° cartilaginous (synchondrosis) Joints (AIPG 2004)
- 10th rib is false rib, since it does not attach to the sternum (NEET Pattern 2013)
- Intercostal nerve is a branch of ventral ram! of thoracic spinal nerves (NEET Pattern 2015)
- Intercostobrachial nerve is a branch of 2nd Intercostal nerve (JIPMER 2002)
- Intercostal nerve 2 Is atypical nerve, since it Innervates upper limb (by contributing to Intercosto-brachial nerve) (NEET Pattern 2013)
- Left phrenic nerve runs anterior to scalenus anterior (AIIMS 2009)
- Pain of pericarditis is carried by phrenic nerve (AIIMS 2007)
- Phrenic nerve supplies peritoneum under diaphragm (NEET Pattern 2016)
- Superior Intercostal artery is a branch of costocervical trunk.

- Upper two posterior Intercostal arteries arise from Superior intercostal artery (NEET Pattern 2015)
- Vasa Vasorum of ascending aorta arises from left coronary artery (NEET Pattern 2015)
- Arch of aorta arises from ascending aorta (NEET Pattern 2016)
- Posterior Intercostal arteries are branches of descending thoracic aorta (NEET Pattern 2015)
- Largest branch of the arch of aorta Is brachiocephalic trunk.
- Commonest variation in the origin of great arteries from the arch of aorta is the origin of left common carotid artery from the brachiocephalic trunk.
- Aortic knuckle Is the projection at the upper end of the left margin of the cardiac shadow in PA New of X-ray chest.
- Sinuses of Valsalva are three dilatations in the ascending aorta above the semilunar valves.
- Left superior Intercostal vein drains into left brachiocephalic vein (NEET Pattern 2015)
- Right bronchial vein drains into azygos vein (NEET Pattern 2016)
- Hemiazygos vein crosses left to right at the level of T8 vertebra (NEET Pattern 2012)
- Direct tributary of superior vena cava is Azygos vein (NEET Pattern 2016)
- Azygos vein and hemiazygos veins Ile in posterior mediastinum (NEET Pattern 2016)
- Superior vena cava opens into right atrium at the level of T5 vertebra (NEET Pattern 2012)
- Thoracic duct commences at T 12 vertebral level (NEET Pattern 2016)
- Thoracic duct does NOT drain right upper part of body (NEET Pattern 2013)
- Thoracic duct passes through posterior and superior mediastinum.
- While doing thoracentesis, it is advisable to introduce needle along upper border of the rib.
- The order of neurovascular bundle in intercostal space from above to below Is: vein-artery-nerve. This order Is NOT observed in first intercostal space (AIIMS 2013)
- Pleural tapping in the mid-axillary line, muscle NOT pierced is transversus thoracis (AIIMS 2007)
- Intercostal block is given at lower border of the rib (NEET Pattern 2016)
- Structures NOT passing through aortic opening Is vagus nerve (NEET Pattern 2018)
- The opening in central tendon of diaphragm transmits Inferior vena cava (AIIMS 2017)
- The opening in central tendon of diaphragm transmits right phrenic nerve branch (NEET Pattern 2013)
- Content(s) of aortic hiatus are azygos vein, thoracic duct and aorta (PGIC 2016)
- Esophagus enters through muscular part of diaphragm (NEET Pattern 2014)
- Structure NOT passing through esophageal hiatus is left phrenic nerve (AIIMS 2011)
- Sensory supply to diaphragm Is through both intercostal nerve and phrenic nerve (NEET Pattern 2016)
- Aorta and thoracic duct (and Azygos vein sometimes) pass posterior to the diaphragm. Whereas, greater splanchnic nerve does not pass posterior to diaphragm, it actually pierces through the crus of the diaphragm to enter the abdomen. (AIIMS 2006)
- Most common site of Morgagni hernia is right anteromedial (RAM). (AIIMS 2009)
- Angle of right principal bronchus from midline is 25° (NEET Pattern 2016)
- The right lower lobar bronchus is most vertical, most nearly continues the direction of the trachea, and is larger in diameter than the left, and therefore, small aspirated objects commonly lodge and the fluid aspirations reach the right lower lobes more often.
- A BPS is aerated by tertiary bronchus (NEET Pattern 2015)
- Medial bronchopulmonary segment is a part of middle lobe of right lung (NEET Pattern 2016)
- Cardiac BPS of right lung is medial basal BPS.
- Medial basal (cardiac) BPS is often absent in the left lung.
- Segments of upper lobe in the right lung are apical, anterior and posterior (NEET Pattern 2013)
- Posterior to sternum is right ventricle (NEET Pattern 2013)

- Apex of the heart is formed by left ventricle (NEET Pattern 2016)
- Lower half of arch of aorta lies behind manubrium sternum.
- Right border of heart is formed by SVC, right atrium and IVC (NEET Pattern 2016)
- Most Axed part of the heart is base of the heart.
- Supraventricular crest Lies between right ventricular Inlet and outlet (JIPMER2017)
- Right ventricle rests on central tendon of diaphragm, forms anterior surface of heart has a wall thickness is 3-5 mm and is crescent shape in cross section (NEET Pattern 2016)
- In TEE (transesophageal echocardiography) most commonly evaluated is left atrium (JIMER 2016)
- Openings in the right atrium Inferior vena cava opening is guarded by Eustachian valve (rudimentary), coronary sinus by Thebesian valve and atrioventricular opening by tricuspid valve.
- SA node is present in the sub-epicardial region. Some authors mention Its presence in myocardium.
- Purkinje fibers are modified cardiac muscle (NEET pattern 2014)
- Right border of heart is formed by the SVC, IVC and the right atrium. Some authors mention ascending aorta in the right border of heart, as well.
- Coronary arteries anastomoses cannot rapidly provide collateral routes sufficient to circumvent sudden coronary obstruction, so they are called as 'functional' end arteries.
- Endocardium is most vulnerable to ischemia when flow through a major epicardial coronary artery is compromised, though the endocardium chiefly receives oxygen and nutrients by diffusion
- or microvasculature directly from the chambers of the heart.
- Right coronary artery (RCA) arises from the right (anterior) aortic sinus of the ascending aorta.
- Left coronary artery (LCA) arises from the left (posterior) aortic sinus of the ascending aorta.
- Coronary arteries are filled with blood during the ventricular diastole. They have maximal blood flow during diastole and minimal blood flow during systole because of compression of the arterial branches in the myocardium during systole.
- Third coronary artery is conus artery (NEET Pattern 2016)
- Arterial supply of ventral 2/3rd of interventricular septum of heart is by left coronary artery (NEET pattern 2015)
- Coronary dominance is determined by posterior Interventricular artery (NEET pattern 2013)
- If the circumflex artery gives off the posterior Interventricular artery, then the arterial supply is called left dominance (AIIMS 2007)
- Posterior Interventricular artery is a branch of right coronary artery in most of the people (right dominance). In 10% population it arises from circumflex artery.
- Kugel's artery is an arterial channel formed by the anastomosis of atrial branch of circumflex artery and similar atrial branch of right coronary artery.
- Coronarysinusis guarded byThebesian valve. (NEET Pattern 2013)
- Great cardiac vein accompanies anterior interventricular artery (Left anterior descending artery) in the anterior Interventricular groove. (NEET Pattern 2013, 16)
- Middle cardiac vein accompanies posterior interventricular artery in the posterior interventricular groove (AIPG 2003)
- Sympathetic nerve supply to heart arises from n-13 and is excitatory to SA node. (NEET Pattern 2013, 14)
- Trachea lies in superior mediastinum.
- Lower limit of superior mediastinum lies at T4 vertebral level (NEET Pattern 2016)
- Attachment of Sibsonts fascia Is at C7 vertebra (NEET Pattern 2015).

Upper Limb

- Upper limb buds appear by the end of week 4 (regulated by lox genes). Lower limb buds appear 2 days later (beginning of week 5).
- Subclavian artery represents the lateral branch of the seventh intersegmental artery. Its main continuation, the axial artery of the upper limb, becomes the axillary and brachial arteries. The original axial vessel ultimately persists as the anterior interosseous artery and the deep palmar arch.
- The nerves related closely to the humerus are Axillary, radial, ulnar (NEET Pattern 2015)
- At the base of the radial styloid process, there Is Insertion of brachioradiales tendon. (NEET Pattern 2012)
- Nutrient arteries to both ulna & radius are branches of anterior interosseus artery branch of ulnar artery.
- Most commonly fractured bone in the body is Clavicle. It occurs at the junction of its lateral one-third and medial two-third
- Three trunks (upper, middle and lower), dorsal divisions Join to form the posterior cord of brachial plexus (NEET Pattern 2015)
- The roots of C-S, 6, 7 contribute to the long thoracic nerve (of Bell) In the neck region (supraclavicular portion of brachial plexus) (NEET Pattern 2013)
- Radial nerve is the largest branch of brachial plexus and Is the continuation of posterior cord (CS-8;T1) (NEET pattern 2014)
- Root value of ulnar nerve - C (7),8; (NEET Pattern 2015)
- Arterial supply to brachial plexus is from the branches of subclavian and vertebral arteries.
- Erb's point is at the Junction of CS and C6 roots (NEET Pattern 2013)
- Radial nerve gives branch to anconeus muscle in the groove (JIPMER 2009)
- Two cutaneous nerves, the lower lateral cutaneous nerve of the arm and the posterior cutaneous nerve of the forearm are given by radial nerve in the radial groove (NEET Pattern 2014)
- A long, slender branch of radial nerve (to medial head of triceps), lies close to the ulnar nerve as far as the lower third of the arm, is frequently called as ulna r collateral nerve (NEET Pattern 2013)
- Injury to radial nerve at wrist leads to Sensory loss on dorsum of 1st web space.
- Median nerve Is also called as Laborers nerve as It supplies the anterior forearm muscles and anterior thumb muscles. These muscles help to push, pull, lift heavy loads by the laborers and if the nerve is damaged they are helpless to carry out all such movements (NEET Pattern 2012)
- Nerve root supplying cutaneous distribution of index finger is C7 (NEET Pattern 2016)
- Dermatome of thumb and index finger is C6; C7 (AIIMS 2013)
- Base of little finger is supplied by C8 dermatome (AIPG 2012)
- The nerve supply of nail bed of index finer is median nerve (NEET Pattern 2013)
- Injury at C7 root, leads to sensory loss at Posterior forearm (NEET Pattern 2013)
- Abduction and lateral rotation of shoulder Is carried out by C5,6 root value, which gets compromised In Erb's palsy.
- Injury to the suprascapular nerve is characterized by atrophy of the supraspinatus and infraspinatus muscles. Deficits will include difficulty in initiation of arm abduction and weakness in external rotation of the arm.
- Injury to the long thoracic nerve results in paralysis of the serratus anterior muscle, causing a winged scapula (the medial border of the scapula moves or protrudes posteriorly away from the thoracic wall) when pushing against resistance. It may also cause difficulty in raising the ann above the head.
- Root value of Supinator Jerk is C5, 6 (NEET Pattern 2015)
- During sentinel lymph node biopsy, the nerves at risk are: intercostobrachial nerve (most common), long thoracic nerve, thoracodorsal nerve.

- Rhomboid muscles and levator scapulae are supplied by the dorsal scapular nerve (NEET Pattern 2015,16)
- The four tendons of flexor digitorum profundus give origin to four lumbricals (NEET Pattern 2015)
- Teres major is supplied by the lower subscapular nerve, which also supplies subscapularis muscle (NEET Pattern 2014)
- Anconeus Is a small muscle on in posterior compartment of forearm. It originates from the humerus (posterior surface of lateral condyle and inserts into ulna (on posterior surface and olecranon). It is Innervated by a branch of the radial nerve (C7,8) In the radial groove of the humerus.
- Winging of scapula Is undue prominence of medial border of scapula, especially when an attempt is made for scapular protraction, occurs due to paralysis of serratus anterior muscle. Winging of scapula is also caused by trapezius and rhomboid palsy involving the accessory nerve and the dorsal scapular nerve, respectively. (NEET Pattern 2012)
- Flexor digitorum superficialis tendon splits into medial and lateral bands, which pass around the flexor digitorum profundus tendon and insert on the base of the middle phalanx, while the flexor digitorum profundus tendon Inserts on the base of the distal phalanx as a single tendon.
- Only muscle that suspends the pectoral girdle from the cranium is trapezius
- Widest muscle on the back of the body is latissimus dorsi
- Climbing muscles are Latissimus dorsi and pectoralis major
- All the rotator cuff muscles are the rotators of the humerus except supraspinatus
- Tendon of supraspinatus is most commonly torn in rotator cuff injury.
- Largest synovial bursa in body is subacromial (subdeltoid) bursa
- Strongest ligament of upper limb Is coracoclavicular ligament
- Most prominent superficial vein in the body Is median cubital vein
- Most commonly used vein for venepuncture is median cubital vein
- Most preferred vein for cardiac catheterization Is basilic vein
- Most of the superficial lymph vessels of the upper limb drain Into Lateral group of the axillary lymph nodes
- Most distal superficial lymph node in the upper limb issupratrochlear/epitrochlear node
- Longest superficial vein of the upper limb is cephalic vein
- Most lateral bony point of the shoulder region Is greater tubercle of the humerus
- Most felt arterial pulse for recording blood pressure is brachial pulse in the cubital fossa
- Best place to compress the brachial artery to stop hemorrhage in the arm and hand is medial aspect of
- Humerus near the middle of arm (site of Insertion of coracobrachialis)
- Neurovascular structures jeopardized in midshaft fracture of the humerus are radial nerve and profunda brach artery
- Damage of the radial nerve in spiral groove causes only weakness in extension of elbow and not the total Inability to extend elbow, because branches of the radial nerve supplying long and lateral heads of triceps arise in axilla, i.e., above radial groove.
- Ligament of Struthers is the fibrous band extending between the supratrochlear spur and medial epicondyle of humerus
- All the flexor muscles of the forearm lie on the front of forearm except brachioradialis, which lies on the back of the forearm
- All the superficial flexors of the forearm are supplied by median nerve except flexor carpi ulnaris, which is supplied by the ulnar nerve
- All the muscles on the back of the forearm are extensors except brachloradialis, which is a flexor of the forearm
- Chief source of blood supply to the forearm is ulnar artery
- Deepest artery on the front of the forearm is anterior Interosseous artery

- Eye of the hand/peripheral eye is median nerve in the hand.
- Common Interosseous artery is a branch of ulnar artery near the elbow joint and divides into anterior and posterior interosseous artery.
- There is often an enlargement or pseudoganglion on the axillary nerve branch to teres minor. The termination of posterior interosseous nerve also shows a pseudo-ganglion Deep fibular nerve in lower limb may also develop a pseudoganglion in a branch to extensor digitorum brevis.
- Fracture of the surgical neck may injure the axillary nerve and the posterior humeral circumflex artery as they pass through the quadrangular space.
- Colles fracture of the wrist is a distal radius fracture in which the distal fragment is displaced (tilted) posteriorly, producing a characteristic bump described as dinner (silver) fork deformity because the forearm and wrist resemble the shape of a dinner fork. If the distal fragment is displaced anteriorly, it is called a reverse Colles fracture (Smith fracture).This fracture may show styloid processes of the radius and ulna line-up on a radiograph.
- Bennett fracture is a fracture of the base of the metacarpal of the thumb. Boxer's fracture is a fracture of the necks of the second and third metacarpals, seen in professional boxers, and typically of the fifth metacarpal in unskilled boxers.
- Tennis elbow (lateral epicondylitis) is caused by a chronic Inflammation or irritation of the origin (tendon) of the extensor muscles of the forearm from the lateral epicondyle of the humerus as a result of repetitive strain. It Is a painful condition and common in tennis players and violinists.

- Golfers elbow (medial epicondylitis) is a painful condition caused by a small tear or an Inflammation or irritation in the origin of the flexor muscles of the forearm from the medial epicondyle. Avoidance of repetitive bending (flexing) of the forearm is advised in order to not compress the ulnar nerve.
- Nursemaid's elbow or pulled elbow is a radial head subluxation and occurs in toddlers when the child is lifted by the wrist. It is caused by a partial tear (or loose) of the annular ligament and thus the radial head to slip out of position.
- Volkmann contracture Is an ischemic muscular contracture (flexion deformity) of the fingers and sometimes of the wrist, resulting from ischemic necrosis of the forearm flexor muscles, caused by a pressure injury, such as compartment syndrome, or a tight cast. The muscles are replaced by fibrous tissue, which contracts, producing the flexion deformity.
- Trigger finger results from stenosing tenosynovitis or occurs when the flexor tendon develops a nodule or swelling that interferes with its gliding through the pulley, causing an audible clicking or snapping.
- Jersey finger (Rugby finger or Sweater finger) is a type of injury due to avulsion of the flexor digitorum profundus (FDP) at the base of the distal interphalangeal Joint.
- First lumbrical space communicates with thenar space whereas, 2, 3 and 4 lumbrical canals are continuous with midpalmar space. Infection from thumb and index finger passes towards the thenar space along the first lumbrical canal. Middle, ring finger and little finger drain towards midpalmar space along the 2, 3 and 4th lumbrical canals.
- Forearm space of Parona lies proximal to the flexor retinaculum and is continuous with the radial and ulnar bursa. Flexor retinaculum separates forearm space of Parona from the thenar and midpalmar space and they are non-continuous.